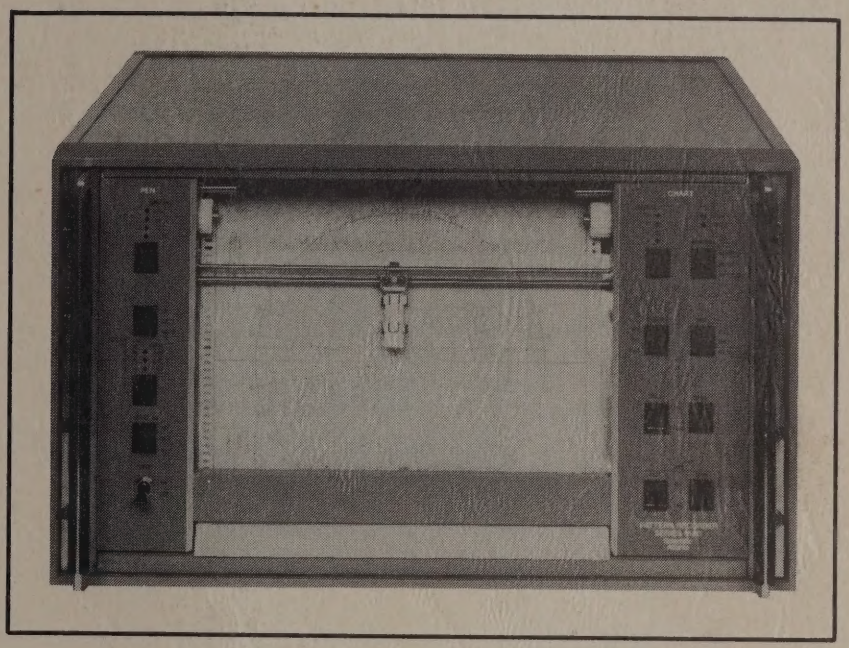
Instruction Manual

Series 1580
Pattern Recorder



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MODEL NO. _____

SERIAL NO. _____

SERIES 1580
PATTERN RECORDER

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TABLE OF CONTENTS

Paragraph		Page
	CHAPTER 1 GENERAL INFORMATION	
1.1	General	1-1
1.2	Purpose of Equipment	1-1
1.3	General Description	1-3
1.4	Accessories	1-8
	A. Model 1586 Crystal-Bolometer Amplifier (CBA)	1-8
	B. Model 1587 DC Amplifier (DCA)	1-9
	C. Model 1588 Synchro Selector	1-10
1.5	Technical Specifications	1-10
	CHAPTER 2 INSTALLATION	
2.1	General	2-1
2.2	Unpacking and Inspection	2-1
2.3	Installation	2-2
2.4	Signal Inputs	2-4
2.5	Special Considerations	2-12
	CHAPTER 3 OPERATION	
3.1	General	3-1
3.2	Front Panel Controls and Indicators	3-1

TABLE OF CONTENTS - continued

Paragraph			Page
3.3	Loading of a Chart Paper Roll and Initial Calibration		3-7
	A.	Preliminary Conditions	3-7
	B.	Loading the Roll of Chart Paper	3-7
	C.	Calibrating to Rectangular Chart Paper	3-11
	D.	Calibrating to Polar Chart Paper	3-15
3.4	Remote Operation		3-18
	A.	Remote Operation Conditioning	3-18
	B.	Control Panel Programming	3-19
	C.	Additional Commands	3-20
	D.	Listen Only Mode	3-24
	E.	Pen/Chart Input Select for Listen Only Mode	3-24
	F.	Front Panel Control for Listen Only Mode	3-26
	G.	Hold Off for Listen Only Mode	3-27
	H.	Installation Procedure for the Listen Only Mode	3-27
3.5	Data Formats		3-28
	A.	Pen Data Format	3-28
	B.	Chart Data Format	3-32

CHAPTER 4
THEORY OF OPERATION

4.1	General		4-1
4.2	The Power Supply Sources		4-1
	A.	±15 Volt dc Supply Sources	4-2

TABLE OF CONTENTS - continued

Paragraph		Page
	B. -5 Volt dc, +12 Volt dc Supply Sources	4-6
	C. +5.0 Volt dc Supply Source	4-6
	D. ±26 Volt dc Supply Sources	4-9
4.3	The Digital Data Processor Circuits	4-11
	A. General	4-11
	B. Mapped Memory I/O	4-18
	C. Firmware Description	4-19
	D. Software Description	4-23
4.4	Central Processor Unit (CPU) Printed Circuit Board Assembly (A3A2)	4-24
4.5	Main Memory Printed Circuit Board Assembly (A3A3) and Optional Memory Printed Circuit Board Assembly (A3A4)	4-34
4.6	Control Panel Interface Printed Circuit Board Assembly (A3A1)	4-39
	A. Pen Control Panel (A1A3)	4-42
	B. Pen Calibrate Assembly (A1A2)	4-43
	C. Chart Control Panel (A1A4)	4-44
4.7	Pen Control Printed Circuit Board Assembly (A3A9) and Chart Control Printed Circuit Board Assembly (A3A10)	4-44
4.8	Pen/Chart Servo Rate Loop Printed Circuit Board Assembly (A3A11)	4-48
4.9	System Servo Printed Circuit Board Assembly (A2A2)	4-51
4.10	Digital Interface Printed Circuit Board Assembly (A3A5 or A3A6)	4-54
4.11	CBA/DCA Interface Printed Circuit Board Assembly (A3A5)	4-55
4.12	Synchro-To-Digital (S/D) Converter Printed Circuit Board Assembly (A3A6) and S/D Transformer (A5)	4-57

TABLE OF CONTENTS - continued

Paragraph		Page
4.13	60 dB Option Printed Circuit Board Assembly (A3A8)	4-59
4.14	IEEE-488 Interface Option Printed Circuit Board Assembly (A3A7)	4-60

CHAPTER 5
MAINTENANCE

5.1	General	5-1
5.2	Electronic Troubleshooting	5-1
5.3	Preliminary Checkout	5-2
5.4	Section A: Control Panel System Checkout	5-8
5.5	Section B: Microprocessor Checkout	5-10
5.6	Section C: Pen System Checkout	5-15
5.7	Section D: Chart System Checkout	5-23
5.8	Section E: Pen System Data Path	5-31
5.9	Section F: Chart System Data Path	5-34
5.10	Section G: Miscellaneous Problems	5-37
5.11	Adjustments and Calibration	5-39
	A. Pen/Chart Controls Adjustments	5-40
	B. Pen Calibration	5-42
	C. Option Selection	5-43
	D. 60 dB Option Calibration	5-46
	E. Paper Sensor Adjustments	5-47
5.12	Regional Service Centers	5-49

TABLE OF CONTENTS - continued

Paragraph		Page
	CHAPTER 6 PARTS LISTS	
6.1	General	6-1
6.2	Explanation of Column Headings	6-1
6.2.1	Ref. Desig.	6-1
6.2.2	Comp. Desig.	6-1
6.2.3	Scientific-Atlanta (S-A) Part No.	6-1
6.2.4	Description	6-1
6.2.5	FSCM	6-1
6.2.6	Mfr. Part No.	6-2
6.3	Ordering Parts	6-2
6.4	Parts Substitution	6-2
	CHAPTER 7 DIAGRAMS	
7.1	General	7-1
7.2	Arrangement of Diagrams	7-1
7.3	Index of Diagrams	7-1
	CHAPTER 8 SUPPLEMENTAL INFORMATION	

LIST OF TABLES

Table	Title	Page
1-1	Series 1580 Pattern Recorder, Identification of Coded Options	1-4
1-2	Series 1580 Pattern Recorder, Technical Specifications	1-10
1-3	Model 1581 Pattern Recorder, Ancillary Equipment Interface Cable Identification	1-19
1-4	Model 1581 Pattern Recorder, Table of Separate Accessories and Supplies	1-20
3-1	Left Front Panel	3-2
3-2	Amplitude Data, 0.1 Resolution	3-29
3-3	Amplitude Data, 0.01 Resolution	3-30
3-4	Phase Data	3-31
3-5	Absolute Pen Data	3-32
3-6	Angular Chart Data 0.001 Degree Resolution	3-33
3-7	Delta Chart Data	3-34
4-1	CPU TMS 9900 Pin Assignments and Functions	4-27
4-2	ROM (EPROM) Device Selection	4-38
4-3	ROM (EPROM) Address Select	4-38
4-4	RAM Address Select	4-39

LIST OF ILLUSTRATIONS

Figure	Title	Page
	Block Diagram - Pattern Recorder Series 1580	1-21
2-1	Observing For and Selecting the Proper Operating Voltage	2-3
2-2	Digital Interface Panel (A6) Arranged to Support Available Options	2-5
2-3	Synchro-to-Digital (S/D) Transformer Assembly (A5)	2-5
2-4	Pin-Out Detail of Interface Cable Assembly No. 162962	2-6
2-5	Pin-Out Detail of Interface Cable Assembly No. 162963	2-7
2-6	Pin-Out Detail of Interface Cable Assembly No. 162964	2-8
2-7	Pin-Out Detail of Interface Cable Assembly No. 162965	2-9
2-8	Pin-Out Detail for Interface Cable Assembly No. 162966	2-10
2-9	Pin-Out Detail for Interface Cable Assembly No. 162967	2-11
2-10	Present Synchro-to-Digital Transformer Assembly Schematic	2-12
2-11	Partial Rear View of Series 1580 Pattern Recorder for Identification of Functions	2-14
2-12	Synchro-to-Digital Transformer Assembly Schematic After Modification	2-14
3-1	Front Panel Controls and Indicators	3-2
3-2	DIP Switch Option Selection Through Control Panel Interface Printed Circuit Board (A3A1)	3-25
4-1	Power Supply Assembly (A2), Simplified Schematic	4-3

LIST OF ILLUSTRATIONS - continued

Figure	Title	Page
4-2	Power Supply Assembly (A2), +15Volt DC Supply Sources, Simplified Schematic	4-5
4-3	Power Supply Assembly (A2), -5 Volt DC, +12 Volt DC Supply Sources, Simplified Schematic	4-7
4-4	Power Supply Assembly (A2), +5 Volt DC Supply Sources, Simplified Schematic	4-8
4-5	Power Supply Assembly (A2), ±26 Volt DC Supply Sources, Simplified Schematic	4-10
4-6	Digital Data Processor Circuits, Simplified Block Diagram	4-13
4-7	Digital Data Bus Routing, Simplified Block Diagram	4-14
4-8	Detailed Block Diagram	4-15
4-9	Main Memory Program Flowchart	4-21
4-10	Outline and Pen Functions of Central Processor Unit (CPU) Printed Circuit Board (A3A2) Microprocessor	4-25
4-11	Central Processor Unit (CPU) Printed Circuit Board (A3A2), Simplified Block Diagram	4-26
4-12	Typical Memory Printed Circuit Board (A3A3 and/or A3A4), Simplified Block Diagram	4-36
4-13	Control Panel Interface Printed Circuit Board (A3A1), Simplified Block Diagram	4-40
4-14	Pen Control PCB (A3A9) and/or Chart Control PCB (A3A10), Simplified Block Diagram	4-45

LIST OF ILLUSTRATIONS - continued

Figure	Title	Page
4-15	Servo Rate Loop Printed Circuit Board (A3A11), Simplified Block Diagram	4-50
4-16	System Servo Printed Circuit Board (A2A2), Simplified Schematic	4-52
4-17	CBA/DCA Interface Printed Circuit Board (A3A5), Block Diagram	4-56
4-18	IEEE-488 Interface Option Printed Circuit Board (A3A7), Block Diagram	4-61
4-19	Timing Waveforms Typical of Normal IEEE-488 Interface PCB Operation	4-63
5-1	Preliminary Checkout Procedures, Maintenance Troubleshooting Flowchart 1	5-3
5-2	Control Panel System Checkout Procedures, Maintenance Troubleshooting Flowchart 2	5-9
5-3	Pen Servo System Checkout Procedures, Maintenance Troubleshooting Flowchart 3	5-12
5-4	Pen Servo System Checkout Procedures, Maintenance Troubleshooting Flowchart 4	5-16
5-5	Chart Servo System Checkout Procedures, Maintenance Troubleshooting Flowchart 5	5-24
5-6	Pen System Data Path Trouble-shooting Procedures, Maintenance Flowchart 6	5-32
5-7	Chart System Data Path Trouble-shooting Procedures, Maintenance Flowchart 7	5-36

LIST OF ILLUSTRATIONS - continued

Figure	Title	Page
5-8	Paper Sensor Components and Locations	5-48

CHAPTER 1
GENERAL INFORMATION

1.1 GENERAL

1.1.1 This instruction manual contains information for the installation, operation, and maintenance of the Scientific-Atlanta Series 1580 Pattern Recorder. Replacement parts lists, schematic diagrams and parts location information are included. It is recommended that, before operating, adjusting, or repair is attempted, the appropriate section of this manual be read carefully. Factory or customer specified modifications to the equipment (when applicable) are described in a Modification Notice and contained in the rear cover envelope of this instruction manual.

1.2 PURPOSE OF EQUIPMENT

1.2.1 The Scientific-Atlanta Series 1580 Pattern Recorder is designed to provide a permanent record of measurement data from antennas and other devices whose output characteristics must be measured as a function of position angle or other parameters such as frequency. The recorded measurement is plotted in ink on graph paper as a function of the angular position of the receiving or transmitting device. It is beyond the scope of this manual to detail all applicable uses of the Series 1580 Pattern Recorder but devices, other than antennas, that use this form of measurement analysis include sound transducers, photometers, infrared and other optical equipments, to list a few.

1.2.2 The Series 1580 Pattern Recorder is designed to use plug-in printed circuit boards to interface either digital or analog input signals for recording. The pen and chart motions provide an X-Y format for obtaining standard rectangular patterns. When the Series 1580 Pattern Recorder is conditioned with available options, polar recordings can be generated by positioning the front panel CHART MODE switch to POLAR and using polar chart paper.

1.2.3 One option of the Series 1580 Pattern Recorder is that it can be remotely programmed and/or computer controlled through the use of the IEEE-488 Interface Bus printed circuit board.

1.2.4 Other optional accessories include the Model 1586 Crystal-Bolometer Amplifier and the Model 1587 DC Amplifier which have been designed to interface an analog input signal from a microwave receiver or a detector output. The Model 1588 Synchro Selector accessory is optionally available and can provide the necessary interface to generate individual recordings from multiple axis synchro sources.

1.2.5 A standard Scientific-Atlanta chart paper can be used with the Series 1580 Pattern Recorder. This chart paper has been designed specifically to maximize the usefulness and flexibility of the Series 1580 Pattern Recorder. Both polar and rectangular chart formats can be obtained in 120 foot (36.5 meters) rolls. The inking is provided through disposable fiber tip pens to provide a highly reliable and clean writing system.

1.2.6 A properly optioned Series 1580 Pattern Recorder can be interfaced to the analog or digital output of any Scientific-Atlanta Microwave Receiver or Digital Display. It is

also compatible with other equipment that provides an input signal within the limits as listed in Table 1-2, Technical Specifications, presented in the last of this chapter.

1.3 GENERAL DESCRIPTION

1.3.1 The Series 1580 Pattern Recorder accepts either analog or digital inputs to control both the chart and pen axis. Both the chart and the pen axis are each separate high-response closed-loop servo systems under control of a microprocessor. The chart servo system positions the graph recording paper as a function of the applied and conditioned angular position input signal. To permit close examination of devices whose amplitude varies rapidly for a small amount of angular change, the normal 360^{o} angular scale presentation may be expanded by the front panel CHART DEGREES switch to provide 90^{o}, 18^{o}, or 9^{o} per cycle.

1.3.2 The pen servo system positions a fiber tip pen on the recording paper in response to the applied and conditioned input signal. Using microprocessor control and front panel interface conditioning, the pen servo system automatically provides translation of the input signal into either a logarithmic, a linear, a square, or a square root response.

1.3.3 The Series 1580 Pattern Recorder family consists of several compatible and interchangeable features. The Model 1581 Pattern Recorder is the basic mainframe and includes all the chart and pen control functions for normal rectangular plotting. Chart function controls include:

- Scale
- Direction
- Record Mode
- Chart Space
- Chart Cycle
- Chart Zero Fast
- Chart Zero Slow

Pen function controls include:

- Pen Response
- Scale
- Offset
- Write/Lift
- Smoothing

1.3.4 Front panel controls on the Model 1581 Pattern Recorder provide selectable pen scale ranges of 10, 20, and 40 dB for a square law detector input or 20, 40, and 80 dB for linear detectors. The chart presentation can be offset by 0, 20, or 40 dB through the position of the front panel OFFSET control to provide closer examination of minor lobe variations, such as in the structure of an antenna pattern.

1.3.5 Available options and accessories that extend the Model 1581 Pattern Recorder capability are coded into the model number identification. A brief description of the identification codes is given in Table 1-1.

Table 1-1
Series 1580 Pattern Recorder
Identification of Coded Options

Identification	Description
Model 1581	Basic mainframe with electronic controls and mechanisms. It requires a desired option to complete an operational function. Option codes are readily identified as shown in this example: MODEL 1581 - (Pen Input)-(Chart Input)-(Other Options)
Pen Input Options -2 (Digital)	The Digital Pen Input option provides a Digital Interface printed circuit board installed in the pen axis circuit. The digital interface function is compatible with either Byte or Parallel BCD signals such as supplied from a Scientific-Atlanta Series 1830 Digital Amplitude Display, Series 1820 Digital Phase Display, or Series 1840 Digital Synchro Display.

Table 1-1 continued

Identification	Description
-3 (Analog, AC)	The AC Analog Pen Input option includes a Model 1586 Crystal-Bolometer Amplifier and a CBA/DCA Interface printed circuit board installed in the pen axis circuit. The Model 1586 Crystal-Bolometer Amplifier accepts signals from a crystal or bolometer detector, or the 1.0 kHz signal from a measurement receiver such as a Scientific-Atlanta Series 1700 Microwave Receiver. The input signals are processed and provided through the CBA/DCA Interface printed circuit board to the pen axis circuits.
-4 (Analog, DC)	The DC Analog Pen Input option includes a Model 1587 DC Amplifier and a CBA/DCA Interface printed circuit board installed in the pen axis circuit. The Model 1587 DC Amplifier accepts direct current input signals, processes and outputs them through the CBA/DCA Interface printed circuit board to the pen axis circuits. The Model 1587 DC Amplifier provides adjustable attenuators to permit recorder full scale sensitivities from 100 millivolts to 10 volts. A differential input used in the Model 1587 DC Amplifier allows either positive or negative voltages to be measured. Also, the dc signal levels can be superimposed on common mode offset voltages of up to 100 volts without affecting the measurement. The Model 1587 DC Amplifier can be used to record dc outputs from most sources including the dc analog outputs from either a Series 1830 Digital Amplitude Display or a Series 1820 Digital Phase Display.
-5 (Analog, AC & DC)	This option includes both a Model 1586 Crystal-Bolometer Amplifier and a Model 1587 DC Amplifier. Either unit may be interfaced to the Model 1581 Pattern Recorder pen axis circuit through the supplied CBA/DCA Interface printed cir-

Table 1-1 continued

Identification	Description
	cuit board. Operation is identical to the descriptions provided for Option -3 or Option -4. Note that although both interface capabilities are provided, only one at a time may be used.
Chart Input Options -6 (Digital Synchro Input Option)	The Digital Chart Input option provides a Digital Interface printed circuit board installed in the chart axis circuit. The digital interface function is compatible with either Byte or Parallel BCD signals such as supplied from a Scientific-Atlanta Series 1840 Digital Synchro Display unit.
-7 (Analog Synchro, 1-Axis Option)	This option includes a Scott-Tee transformer module and a S/D Converter printed circuit board installed in the chart axis circuit to control chart movement from one axis of synchro data. The Model 1581 Pattern Recorder can be programmed while using this option to respond to either a 1:1 or a 36:1 synchro ratio (i.e., synchro revolutions per positioner turntable rotation). This option is compatible with the synchro transmitter outputs from most antenna measurement positioners.
-8 (Analog Synchro, 4-Axis Option)	This option includes a Model 1588 Synchro Selector and is similar to Option -7. The Model 1588 Synchro Selector provides convenient operator selection of one (and up to four) axes of positioner motion to control the Model 1581 Pattern Recorder chart movement. The Model 1588 Synchro Selector accepts 1:1, 36:1, or dual speed synchro information from an antenna positioner, model tower, source tower, etc., to provide chart movement control input signals. Internal switches within the Model 1588 Synchro Selector permit independent selection for each axis of synchro data to be either 1:1 or

Table 1-1 continued

Identification	Description
	36:1 information. These internal switches also identify the selected function to the Model 1581 Pattern Recorder permitting automatic chart mode correction as each axis is selected. An auxiliary output connector on the Model 1588 Synchro Selector provides for outputting selected synchro information to other equipment such as a Series 1840 Digital Synchro Display position indicator.
Other Options -9 (Polar Display Output)	The Polar Display Output option includes the necessary printed circuit boards required to provide polar chart recording format in addition to the standard rectangular chart formats. When this option is installed, the polar and rectangular chart formats are switch selectable from the Model 1581 Pattern Recorder front panel. This convenience leaves the operator to be responsible for installing the correct chart paper reflecting the selected mode of operation.
-10 (IEEE 488-1975 Interface Option)	The IEEE 488-1975 Interface option includes both the IEEE 488 Option printed circuit board and the components of Option -9. Note that this option is independant and will operate with or without Pen Input and/or Chart Input options. The IEEE 488-1975 Interface option provides a compatible interface for complete remote programming of the Model 1581 Pattern Recorder. All necessary front panel control functions as well as measurement and position data can be programmed through the interface.
-11 (60 dB Chart Scale Option)	The 60 dB Chart Scale option includes the 60 dB Option printed circuit board. This option is for use with the expanded mode capability of either a Model 1711 Microwave Receiver or a Model 1712 Microwave Receiver. This option converts the dynamic range of the Square Law - 40 dB switch position up to 60 dB.

1.4 ACCESSORIES

1.4.1 Three accessory units are available for the Model 1581 Pattern Recorder to increase its capabilities and flexibility. These accessories are included as part of the options or available separately and are described in the following paragraphs. Each accessory is a separate chassis which can be purchased initially with the Model 1581 Pattern Recorder or added later when needed.

A. MODEL 1586 CRYSTAL-BOLOMETER AMPLIFIER (CBA)

1.4.2 The Model 1586 Crystal-Bolometer Amplifier (CBA) accepts the output of a crystal detector, a bolometer detector, or the 1.0 kHz output signal from a measurement receiver, such as a Scientific-Atlanta Series 1700 Microwave Receiver. The function of the Model 1586 Crystal-Bolometer Amplifier is to properly condition these signals before they are applied to the Model 1581 Pattern Recorder.

1.4.3 A Model 1586 Crystal-Bolometer Amplifier is provided with a front panel SIGNAL LEVEL meter and variable ATTENUATOR controls which permit observing full scale sensitivities up to 1.0 microvolt. A separate front panel switch allows the selection between either bolometer detector or crystal detector inputs. The Model 1586 Crystal-Bolometer Amplifier provides a bias voltage supply that eliminates the normal need of a separate power source to properly bias a bolometer detector.

1.4.4 The Model 1586 Crystal-Bolometer Amplifier incorporates a narrow band (25 Hz) input filter to maximize sensitivity and reduce noise. Sensitivities of up to 1.0 microvolt can be achieved with average noise levels as low as 0.015 microvolts. A Model 1586 Crystal-Bolometer Amplifier is also supplied with a 1000 Hz input filter (1025 Hz for a 50 Hz power source) as

standard equipment. Other frequencies between 500 and 2500 Hz can be supplied on special order. Normal operation with a Model 1586 Crystal-Bolometer Amplifier requires that the Model 1581 Pattern Recorder be provided with the CBA/DCA Interface printed circuit board option installed in the proper card cage connector.

B. MODEL 1587 DC AMPLIFIER (DCA)

1.4.5 The Model 1587 DC Amplifier (DCA) accepts direct current input signals and properly conditions these signals before they are applied to the Model 1581 Pattern Recorder. Front panel attenuators provide for signal level adjustments which can range between 100 millivolts and 10 volts dc to obtain full scale deflection from the Model 1581 Pattern Recorder pen system. A differential input configuration allows either positive or negative voltages to be measured. Furthermore, these dc signal levels can be superimposed on common mode offset voltages of up to 100 volts without affecting the measurement accuracy.

1.4.6 The offset voltage technique permits an operator to establish the "pen zero" to any point on the chart being used. This feature also allows the recording of a signal which varies plus and minus relative to a reference voltage. Front panel indicators will illuminate to indicate signal overload and incorrect signal polarity conditions.

1.4.7 A Model 1587 DC Amplifier can be used to record the dc outputs for most sources, including the dc analog output signals from equipment such as the Scientific-Atlanta Series 1800 Digital Display units. Normal operation with a Model 1587 DC Amplifier requires that the Model 1581 Pattern Recorder be provided with the CBA/DCA Interface printed circuit board option installed in the proper card cage connector.

C. MODEL 1588 SYNCHRO SELECTOR

1.4.8 The Model 1588 Synchro Selector connects directly into the input of the Synchro-to-Digital (S/D) Converter printed circuit board through a Scott-Tee Transformer Module which will be attached to a rear panel connector on the Model 1581 Pattern Recorder. This accessory matches any one of four axis synchro signals, either 1:1 or 36:1 ratio, to coordinate the chart mechanisms with the pen responses through normal operation of the Model 1581 Pattern Recorder.

1.5 TECHNICAL SPECIFICATIONS

1.5.1 A summary of the technical specifications applicable to the features and accessories of the Series 1580 Pattern Recorder is listed in Table 1-2.

Table 1-2
Series 1580 Pattern Recorder
Technical Specifications

Model 1581 Pattern Recorder

Feature	Comments
Operation	
Manual	Requires Pen System and Chart System Interfaces.
Remote	Requires the IEEE-488 printed circuit board (P/N 219125) option.
I/O Interface Signal Input	Requires the Digital Interface printed circuit board (P/N 219076) option. This option also provides IEEE-488 bus compatibility.

Table 1-2 continued

Feature	Comments
Pen/Chart Function	Either analog or digital with appropriate interface printed circuit board. See Table 1-1.
Chart Paper Characteristics	Roll type at 10.6 inches (27 cm) wide by 120 feet (36.5 cm) long. Approximate cycles per roll: 66 Full Scale Rectangular 107 Half Scale Rectangular 101 Polar
Marking Pen	Disposable fiber tip. Available in: Red (P/N 164718) Blue (P/N 164719) Green (P/N 164720) Black (P/N 164721)
Power Requirements	115V or 230V ac at 50 to 60 Hz. Approximately 500 watts dissipation.
Dimensions	Bench Cabinet Height: 10.5 in. (26.67 cm) Width: 19 in. (48.26 cm) Depth: 22 in. (55.88 cm)
Weight	Net: 55 lbs (25 kgs) Shipping: 70 lbs (32 kgs)
CHART SYSTEM	The following features are mostly front panel switch selectable.
Digital Data Rate	The inputs are sampled at a minimum of every 4 milliseconds (f = 250 Hz).
Chart Scales	360, 90, 18, or 9 degrees per cycle, switch selectable.

Table 1-2 continued

Feature	Comments
Chart Channel - Digital Input Resolution	360° Position = 0.4 degree 90° Position = 0.1 degree 18° Position = 0.02 degree 9° Position = 0.01 degree
Chart Speed	30 inches (76 cm) per second (maximum)
Chart Mode	Full Scale = Rectangular, 11 x 17 inches (27 x 43 cm) (Nominal) Half Scale = Rectangular 8.5 x 11 inches (22 x 27 cm) (Nominal) Polar = 7.86 inches (19x5 cm) diameter graph on an 8.5 x 11 inches (22 x 27 cm) chart (Nominal)
Cycle-to-Cycle Length	Full Scale = 21.25 in. (54 cm) Half Scale = 13.39 in. (34 cm) Polar 14.17 in. (36 cm)
Chart Position Error	
Rectangular Format	
Static	1:1 Synchro input = 0.02 in. (0.05 cm) 36:1 Synchro input = 0.015 in. (0.038 cm)
Dynamic	1:1 Synchro input = 0.06 in.*(0.152 cm*) 36:1 Synchro input = 0.05 in.*(0.127 cm*) *at 4 in. per second
Polar Format	
Static	1:1 Synchro input = 0.25° 36:1 Synchro input = 0.05°
Dynamic	1:1 Synchro input = 1.5° at 5 rpm 36:1 Synchro input = 0.1° at 1 rpm
Chart Zero	Fast = 3.5 in. per second (8.9 cm/sec) Slow = 0.3 in. per second (0.76 cm/sec)
Chart Direction	Forward or Reverse

Table 1-2 continued

Feature	Comments
PEN SYSTEM	The following features are mostly front panel switch selectable.
Digital Data Rate	The inputs are sampled at a minimum of every 4 milliseconds. (f = 250 Hz)
Modes	Logarithmic, Linear, Square, Square Root
Pen Channel - Digital Input Resolution	Logarithmic Response, 80 dB Range = 0.1 dB
Dynamic Ranges	
Square Law Detector input	10, 20, or 40 dB (Can be expanded to 60 dB using the P/N 219126 option. See Table 1-1.)
Linear Detector input	20, 40, or 80 dB
Operating Temperature Range	+10 to +40°C (Guaranteed Specification) 0 to 50°C (Reduced Specification)
Storage Temperature Range	-20 to +85°C
Offset	
Linear Detector input	0, 20, or 40 dB
Position Accuracy*	
Rectangular	Linear: ±0.3% full scale Logarithmic: ±0.15 dB Square or Square Root: ±0.5% full scale

*40 dB Dynamic Range

Table 1-2 continued

Feature	Comments
Polar	Linear: ±0.3% full scale Logarithmic: ±0.15 dB Square or Square Root: ±0.5% full scale
Maximum Writing Speed	60 inches (152 cm) per second

Model 1586 Crystal-Bolometer Amplifier

Feature	Comments
Operation	Manual
Dimensions (Excluding Connectors)	Height: 3.5 in. (8.89 cm) Width: 19 in. (48.26 cm) Depth: 9 in. (22.86 cm)
Weight	Net 11 lbs (5 kgs) Shipping: 20 lbs (9 kgs)
Power Requirements	Supplied from the Model 1581 Pattern Recorder
INPUT CHARACTERISTICS	(The following features are front panel selectable or as noted.)
Detector	Crystal or Bolometer
Cable	Coaxial or Triaxial (rear panel access)
Frequency	1000 Hz (1025 for 50 Hz operation) (NOTE: Center frequencies between 500 and 2500 Hz are available on special order.)
3 dB Bandwidth	25 Hz

Table 1-2 continued

Feature	Comments
Impedance	
Crystal	5000 ohms (Nominal)
Bolometer	1000 ohms (Nominal)
Average Noise (referenced to 200 ohm source)	0.015 microvolts
Maximum Pen Range	1.0 microvolt to 1.0 volt full scale, adjustable
Attenuation	(NOTE: The following specifications are based on Square Law input.)
Step Increment	Three 10 dB steps
Variable	One control for $\geq$ 10 dB
Total Maximum	$\geq$ 40 dB
Linearity (including the Model 1581 Pattern Recorder Pen System)	(NOTE: The following specifications are based on the Square Law input.)
Logarithmic	±0.15 dB
Linear	±0.3% full scale
Square and Square Root	±0.5% full scale
Signal Level Meter	Set point equals full scale (0 dB)
Bolometer Bias	0 to 15 milliamperes, adjustable
Output Characteristics	
Recorder	Interfaces directly with the P/N 158391 CBA/DCA Interface printed circuit board.
Auxiliary	
Analog AC	5.0 volts peak-to-peak maximum
Analog AC	+10.0 volts maximum

Table 1-2 continued

Model 1587 DC Amplifier

Feature	Comments
Operation	Manual
Dimensions (Excluding Connectors)	Height: 3.5 in. (8.89 cm) Width: 19 in. (48.26 cm) Depth: 8 in. (20.23 cm)
Weight	Net: 9 lbs (4 kgs) Shipping: 15 lbs (7 kgs)
Power Requirements	Supplied from the Model 1581 Pattern Recorder
INPUT CHARACTERISTICS	(The following features are front panel selectable or as noted.)
Type	Differential (balanced)
Range	0.10 to 10.0 volts dc full scale
Common Mode Offset Voltage	From 0 to 100 volts
Polarity	Plus, Minus, or Bipolar (±5V max Bipolar)
Average Noise Input Connectors to accept S-A Models 1820 or 1830 signals	100 microvolts
Attenuation	(NOTE: The following specification is based on a linear input.)
Variable	One control for $\geq$ 20 dB
Indicators	
AMPLIFIER OVERLOAD	Illuminates to indicate signal input is exceeding full scale level.
REVERSE INPUT POLARITY	Illuminates to indicate incorrect polarity signal connected to the input.

Table 1-2 continued

Feature	Comments
LINEAR OFFSET RANGE	FINE-MEDIUM-COARSE (representing a 0 to 5 volt range)
Output Characteristics	
Recorder	Interfaces directly with the P/N 158391 CBA/DCA Interface printed circuit board.
Auxiliary	
Analog DC	+10 volts full scale maximum

Model 1588 Synchro Selector

Feature	Comments
Operation	Manual
Dimensions (Excluding Connectors)	Width: 3.5 in. (8.89 cm) Length: 19 in. (48.26 cm) Depth: 6.2 in. (15.75 cm)
Weight	Net: 5 lbs (2.3 kgs) Shipping: 15 lbs (7 kgs)
Power Requirements	None
Input Characteristics	
Number of Axis	4 (maximum)
Type	3-wire synchro, 115/90 volts, 50 to 60 Hz
Configuration	1:1/36:1 or 1:1 and 36:1

Table 1-2 continued

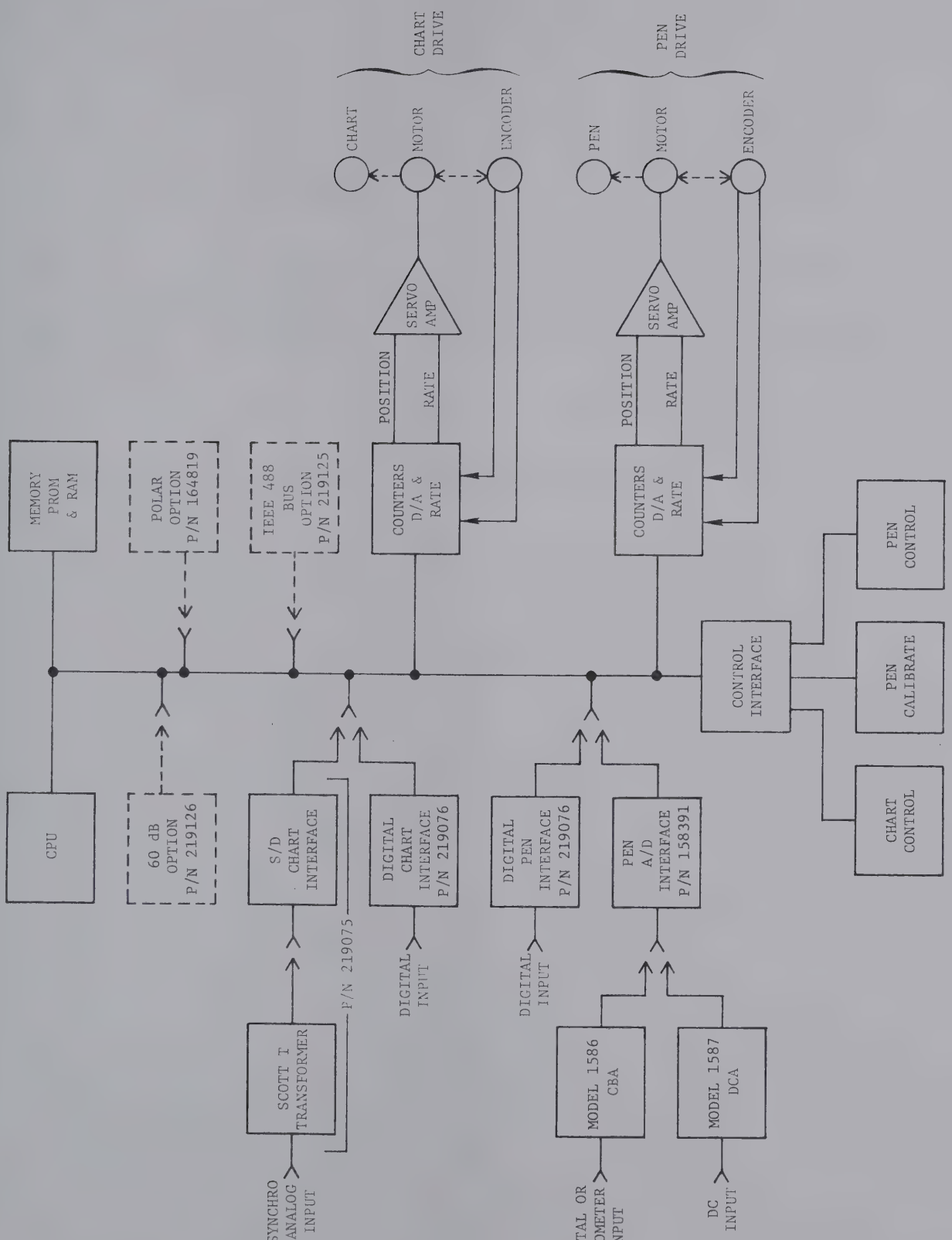
Feature	Comments
Output Characteristics	
Axis	One of four, switch selectable
Synchro	Internally selectable at 1:1 or 36:1 for each of four axis.
Configuration	Interfaces directly to the P/N 219075 Chart Synchro Interface.
Parallel Outputs	Auxiliary Indicator Units

Table 1-3
Model 1581 Pattern Recorder
Auxiliary Equipment
Interface Cable Identification

S-A Part No.	Quantity	Description
162962	1	Interface Cable, Model 1581 Pattern Recorder to Series 1840 Digital Synchro Display unit for parallel BCD signal format, 10 feet long.
162963	1	Interface Cable, Model 1581 Pattern Recorder to Series 1840 Digital Synchro Display unit for byte BCD signal format, 10 feet long.
162964	1	Interface Cable, Model 1581 Pattern Recorder to Series 1820 Digital Phase Display unit for parallel BCD signal format, 10 feet long.
162965	1	Interface Cable, Model 1581 Pattern Recorder to Series 1820 Digital Phase Display unit for byte BCD signal format, 10 feet long.
162966	1	Interface Cable, Model 1581 Pattern Recorder to Series 1830 Digital Amplitude Display unit for byte BCD signal format, 10 feet long.
162967	1	Interface Cable, Model 1581 Pattern Recorder to Series 1830 Digital Amplitude Display unit for parallel BCD signal format, 10 feet long.

Table 1-4
Model 1581 Pattern Recorder
Table of Separate Accessories and Supplies

Identification	Description
P/N 219076	Digital Interface Printed Circuit Board
P/N 158391	CBA/DCA Interface Printed Circuit Board
P/N 219075	S/D Converter Interface System
P/N 219125	IEEE-488 Option Printed Circuit Board (Requires Optional Memory PCB)
P/N 164819	Optional Memory Printed Circuit Board
P/N 219126	60 dB Optional Printed Circuit Board and Cable Set
Rectangular Chart Paper - Full Scale	
Type 219	40 dB Log versus Angle
Type 225	60 dB Log versus Angle
Type 226	80 dB Log versus Angle
Type 224	Linear versus Angle
Type 228	Phase versus Angle
Rectangular Chart Paper - Half Scale	
Type 227	40 dB Log versus Angle
Type 231	60 dB Log versus Angle
Type 232	Linear versus Angle
Polar Chart Paper	
Type 220	40 dB Log versus Angle
Type 229	60 dB Log versus Angle
Type 230	Linear versus Angle.



Block Diagram, Pattern Recorder Series 1580

CHAPTER 2
INSTALLATION

2.1 GENERAL

2.1.1 This chapter contains information necessary to install the Series 1580 Pattern Recorder and prepare it for initial operation. Operating instructions are provided in CHAPTER 3 - OPERATION.

2.2 UNPACKING AND INSPECTION

2.2.1 Carefully unpack the shipping cartons observing all instructions that may be printed on the carton. Separate the packing material from the main units and any packages of loose items (i.e., hardware, cables, connectors, etc.). Temporarily set the shipping cartons and packing material aside in a safe place and inspect the units and associated items, if any, for shipping damage. If damage is evident, contact both the carrier and the nearest Scientific-Atlanta sales representative immediately. Save the packing materials and shipping papers for inspection by the carrier's representative. Do not return a unit to Scientific-Atlanta without receiving specific return shipment instructions.

2.2.2 Save the shipping cartons and packing material until satisfactory operation of the Series 1580 Pattern Recorder is determined. The shipping cartons and packing material may then be used for storage or protection during further transport of the equipment if necessary.

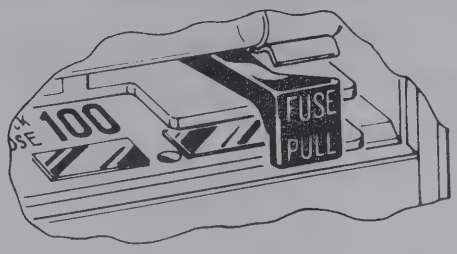
2.3 INSTALLATION

2.3.1 The Series 1580 Pattern Recorder is shipped assembled and ready to operate. If it is to be operated alone and as a separate unit of a system, prepare an area which is convenient and where cable lengths can be as short as possible.

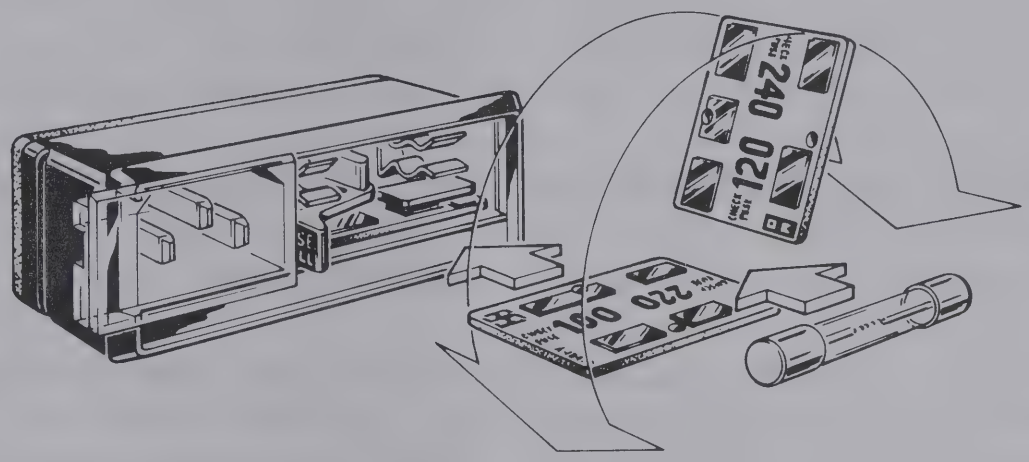
2.3.2 The Series 1580 Pattern Recorder is also designed to be mounted in a 19-inch rack. It can be removed from the Optima® cabinet and physically replace a Scientific-Atlanta Rectangular Recorder of a different Model Number but the electronic interfacing will require using the cables designed for the Series 1580 Pattern Recorder and new Rack Slides.

2.3.3 Before connecting the ac power cord to the rear panel connector, check that the front panel POWER switch is positioned to OFF. Measure the ac power source at the receptacle. Check that the operating voltage of the Series 1580 Pattern Recorder is compatible with the measured ac power source. If necessary, refer to Figure 2-1 for further instructions. Be sure to check that the fuse rating agrees with the rear panel decal according to the operating voltage.

2.3.4 If an optional Model 1586 Crystal-Bolometer Amplifier, Model 1587 DC Amplifier, and/or Model 1588 Synchro Selector unit is to compliment the operation of a Series 1580 Pattern Recorder, the appropriate interface printed circuit board must be provided. When a CBA/DCA Interface printed circuit board (A3A5) is provided, two interface cables are also provided to connect with either a Model 1586 Crystal-Bolometer Amplifier or a Model 1587 DC Amplifier. If a Synchro-to-Digital (S/D) Converter printed circuit board (A3A6) is provided, the S/D Transformer Assembly (A5) must also be attached to the Series 1580 Pattern Recorder rear panel. The S/D Transformer Assembly (A5)



Operating voltage is shown through the sliding plastic window.



HOW TO SELECT OPERATING VOLTAGE

1. Remove the ac power cord connector.
2. Slide the plastic window to the left.
3. Carefully operate FUSE PULL tab to the left.
4. Carefully remove both the fuse and printed circuit board. A small hole is provided to accommodate a wire pull if necessary.
5. Correctly orient the printed circuit board so the desired voltage is located on the top left side.
6. Carefully return to printed circuit board to the original location. Be sure it is securely seated.
7. Return FUSE PULL tab to the normal position.
8. Replace the original fuse with one selected for correct fuse value.

Illustrations courtesy of Corcom Corp., Chicago, Ill.

Figure 2-1. Observing For and Selecting the Proper Operating Voltage

interfaces synchro signals from either a Model 1588 Synchro Selector or other source. Figures 2-2 and 2-3 identify the location and function of common optional interface connections for a Series 1580 Pattern Recorder.

2.4 SIGNAL INPUTS

2.4.1 The normal operation of the Series 1580 Pattern Recorder depends on receiving proper signal format through compatible interface connections. During installation, inputs for both the Pen System and the Chart System should be rechecked to assure proper interface. Scientific-Atlanta offers special cables to interface between the Series 1580 Pattern Recorder and Scientific Atlanta display units. These cables are identified for specific display units and interface formats in Table 1-3.

2.4.2 The Pen Input System and Chart Input System can be interfaced with many devices whose output characteristics vary as a function of position or other parameters such as frequency. The list of devices include photometers, transducers, infrared/optical units as well as plotting antenna measurement data. Both the pen and chart systems interface with other equipment through the Digital Interface Panel Assembly, shown in Figure 2-2. Connector J1 provides interface with the Pen System and connector J2 provides interface with the Chart System. Connector J3 provides interface for the IEEE-488 option, when used and connector J4 provides interface for the 60 dB Option. Although special interface cables are available for interfacing with Scientific-Atlanta display equipment, the individual pin-out functions for each cable connector is shown in Figures 2-4 through 2-9, respectively. These references will be of assistance when a customer desires to interface equipment to the Series 1580 Pattern Recorder.

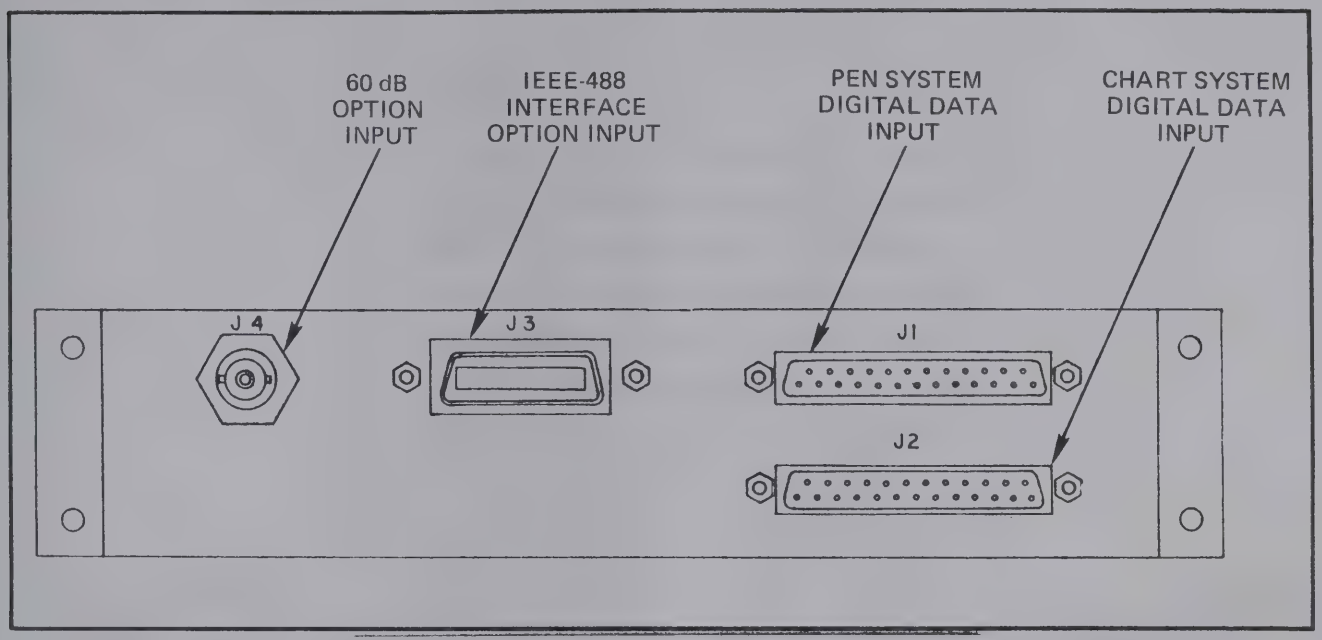


Figure 2-2. Digital Interface Panel (A6) Arranged to Support Available Options

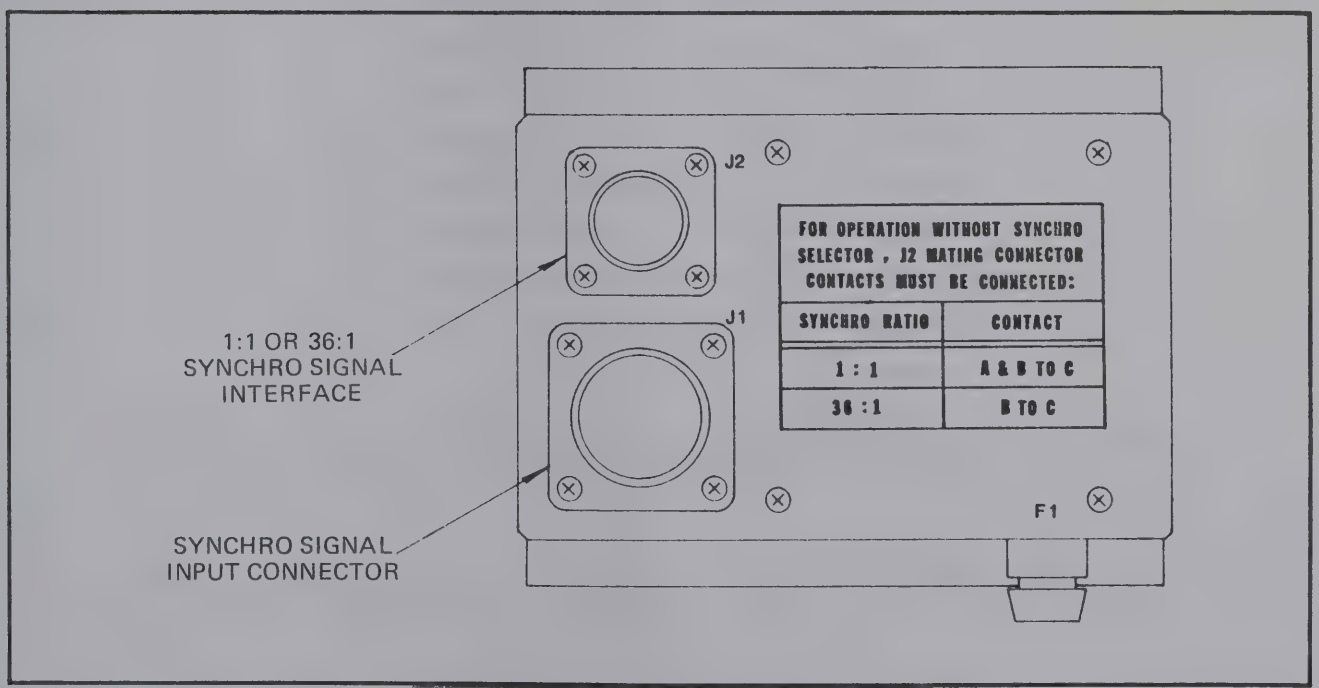


Figure 2-3. Synchro-to-Digital (S/D) Transformer Assembly (A5)

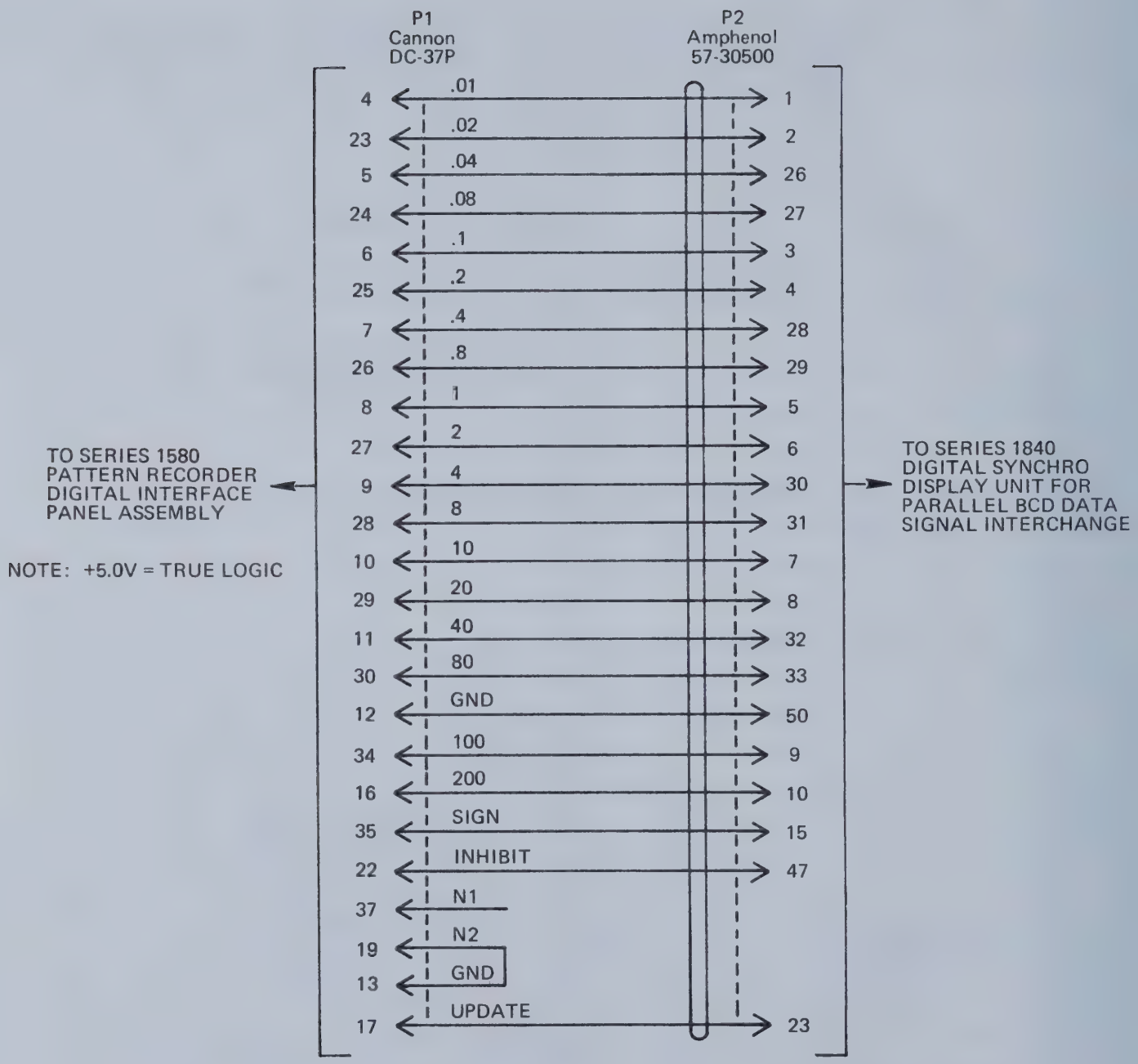


Figure 2-4. Pin-Out Detail of Interface Cable Assembly No. 162962

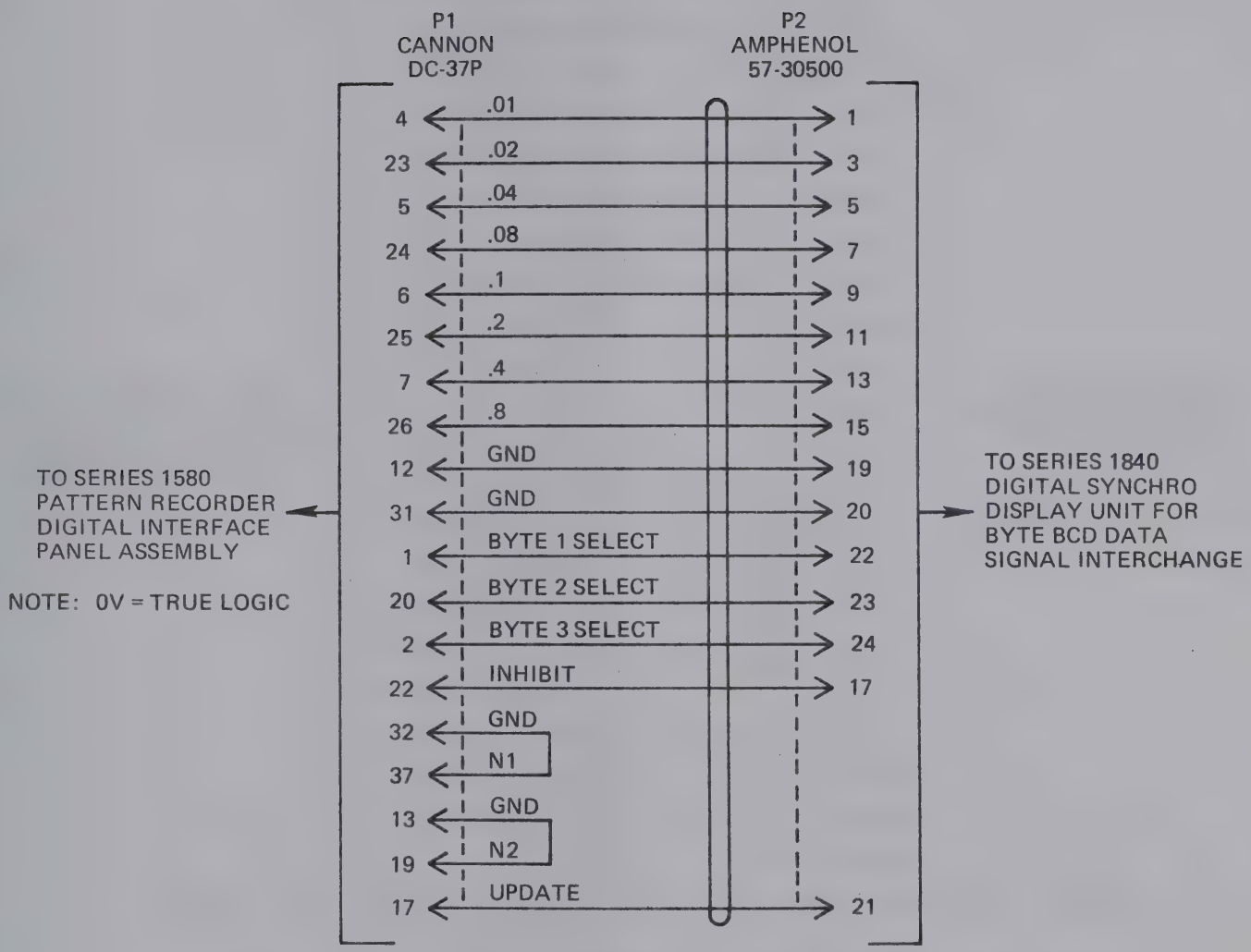


Figure 2-5. Pin-Out Detail of Interface Cable Assembly No. 162963

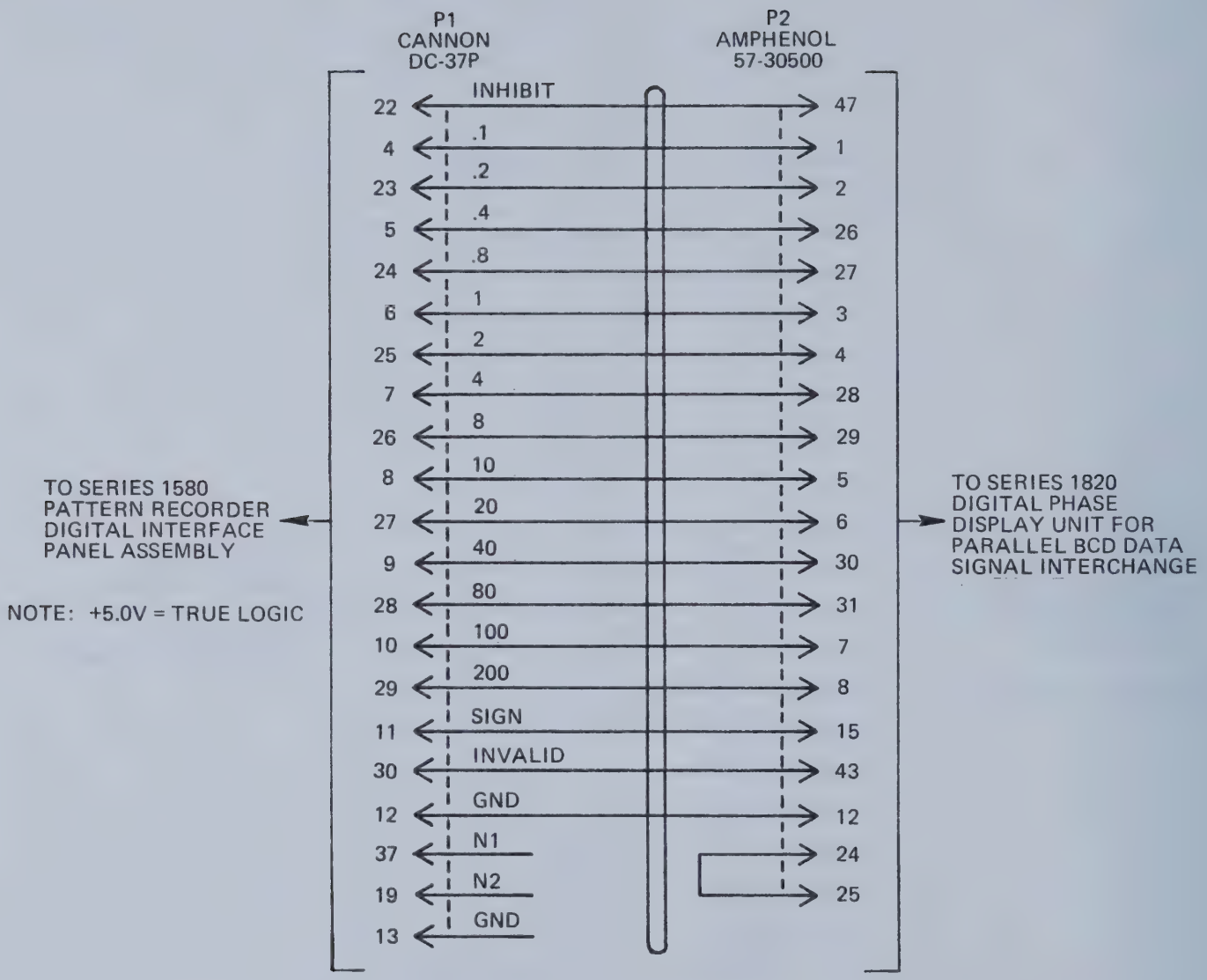


Figure 2-6. Pin-Out Detail of Interface Cable Assembly No. 162964

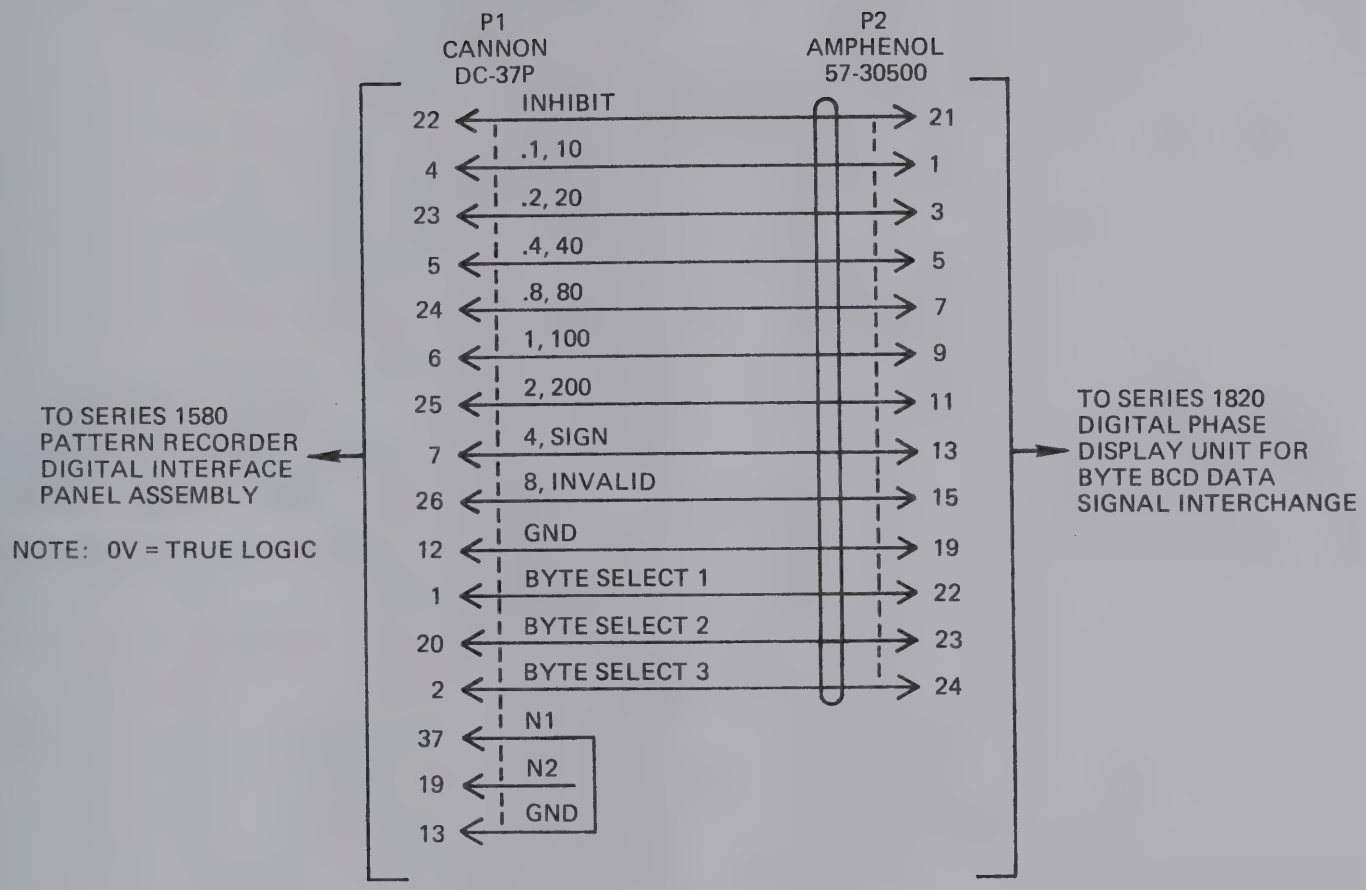


Figure 2-7. Pin-Out Detail of Interface Cable Assembly No. 162965

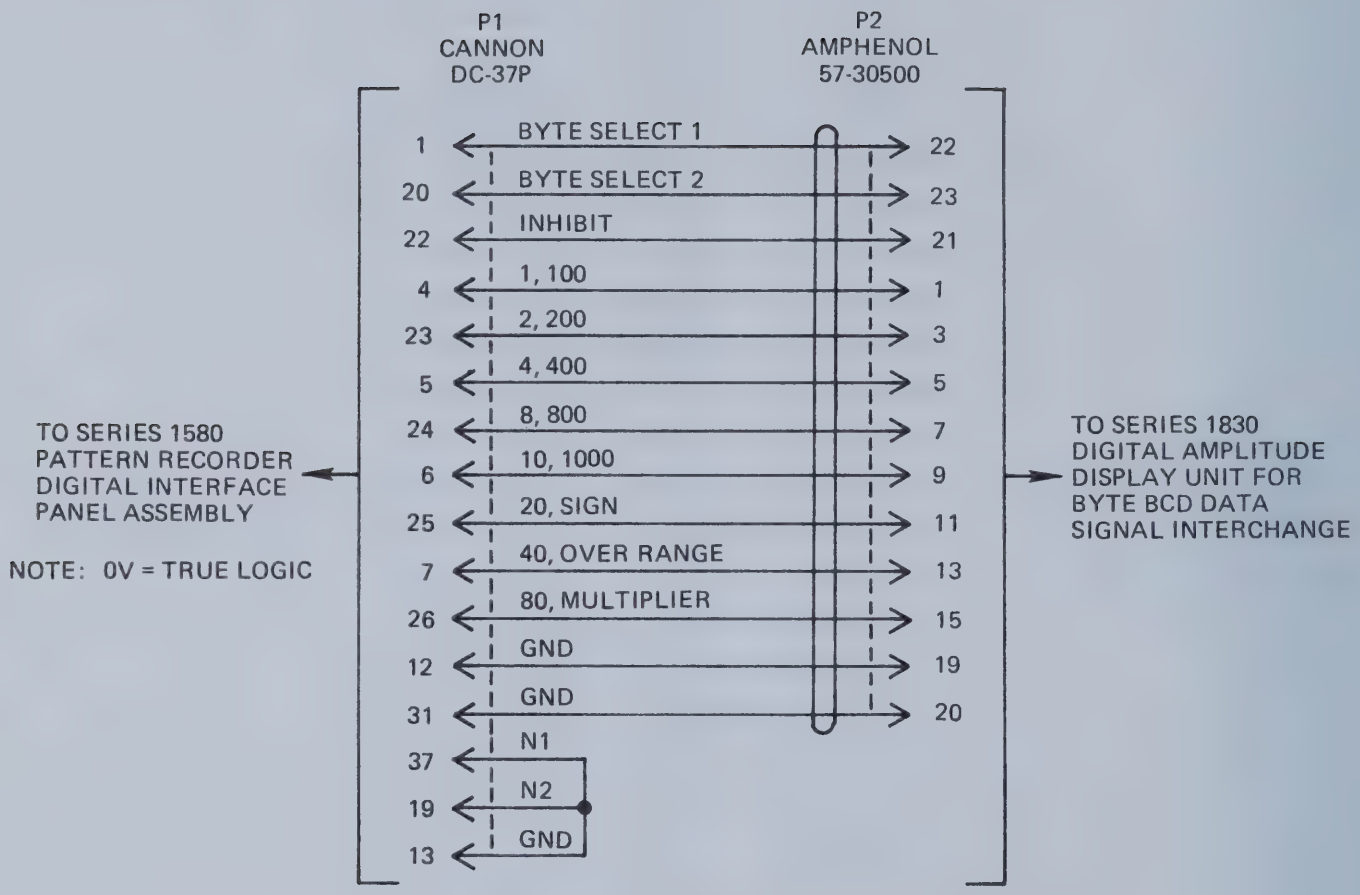


Figure 2-8. Pin-Out Detail of Interface Cable Assembly No. 162966

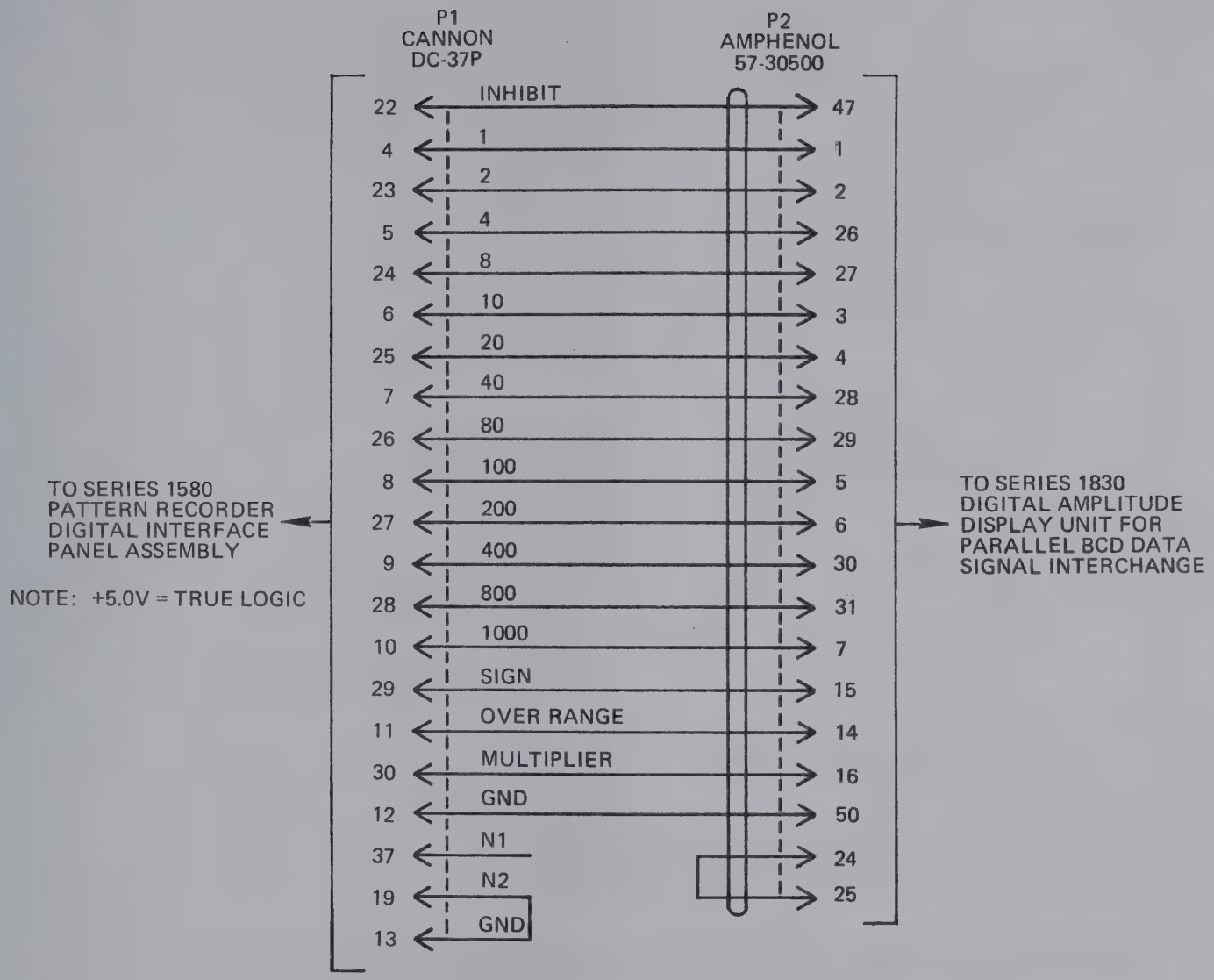


Figure 2-9. Pin-Out Detail of Interface Cable Assembly No. 162967

2.5 SPECIAL CONSIDERATIONS

2.5.1 It is possible for the Series 1580 Pattern Recorder to perform erratically when a synchro input signal from a remote location has a 60-Hertz reference not in phase with the ac source applied to the recorder. The synchro input signal is applied through the Synchro-to-Digital Option which is factory wired as shown in Figure 2-10.

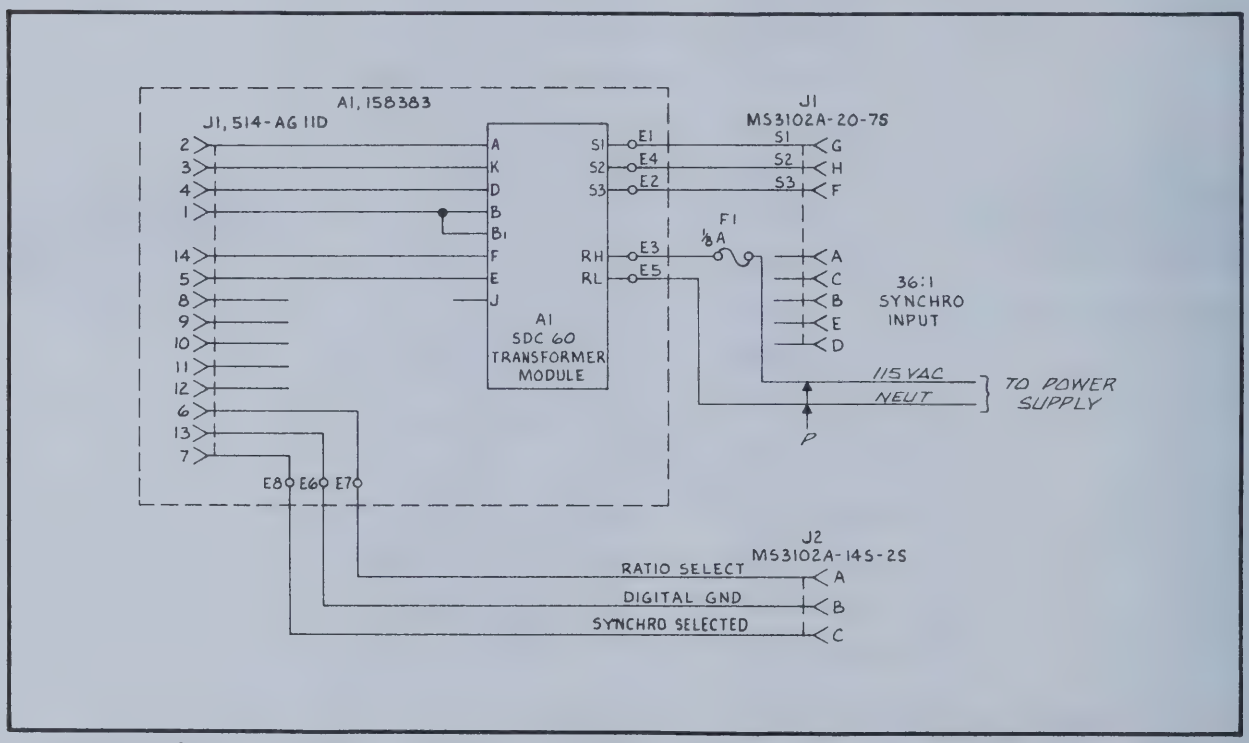


Figure 2-10. Present Synchro-to-Digital Transformer Assembly Schematic

2.5.2 One solution to obtain normal operation when a difference in phase reference is discovered is to provide a direct connection with the remotely located synchro. This can be accomplished by providing the following modification to the Synchro-to-Digital Transformer Assembly.

1. Remove the factory connected 60 cycle synchro reference connections from the power supply terminal strip. Figure 2-11 identifies the two reference wires as they would be seen from the rear of the Series 1580 Pattern Recorder.

2. Connect the reference wires to the Synchro Signal Input Connector, J1, at pins A and C. Be sure to make the Neutral wire connection to pin C and the second wire to pin A. This makes the Synchro-to-Digital option to be schematically represented as shown in Figure 2-12.

3. The range cable assembly should provide a direct connection between the remote synchro and the Synchro-to-Digital Transformer Assembly (A5) connector J1. The Synchro Signal Interface connector, J2, should be strapped according to the synchro ratio desired as noted on the decal.

4. Make appropriate notations in the Instruction Manual that this modification has been made. It may effect a speedy repair in the future should a malfunction occur.

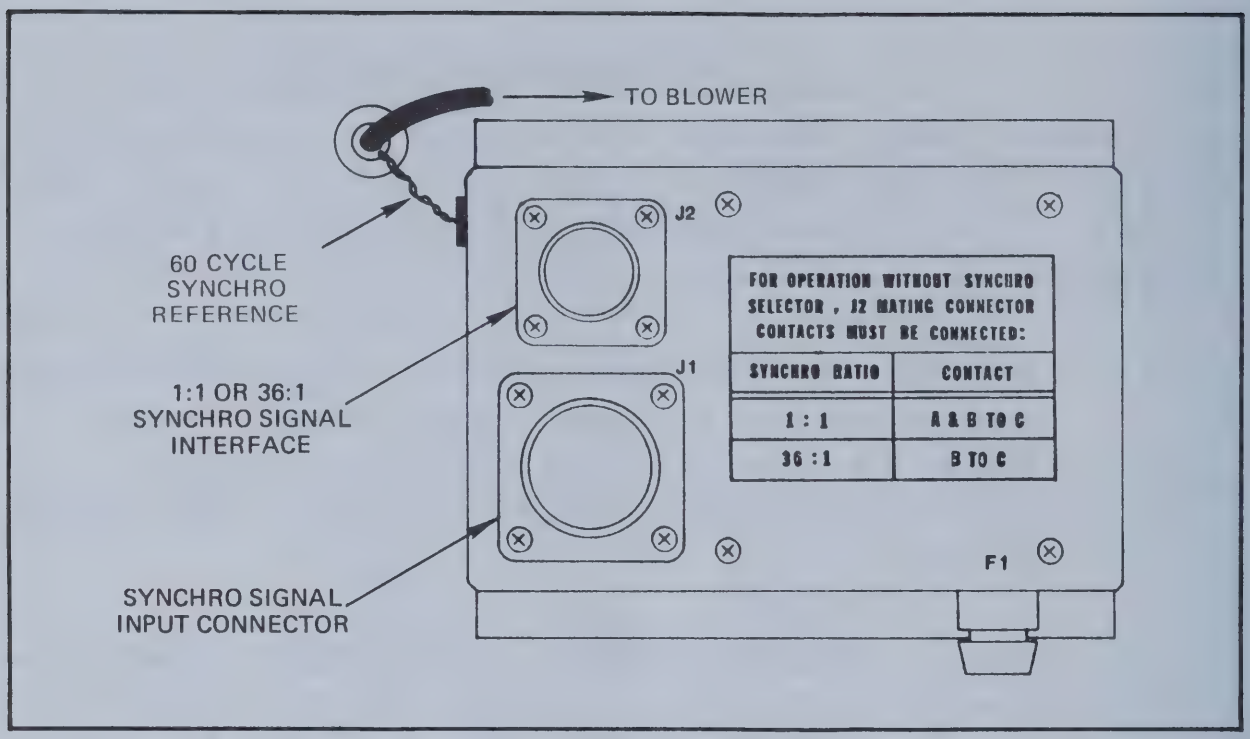


Figure 2-11. Partial Rear View of Series 1580 Pattern Recorder for Identification of Functions

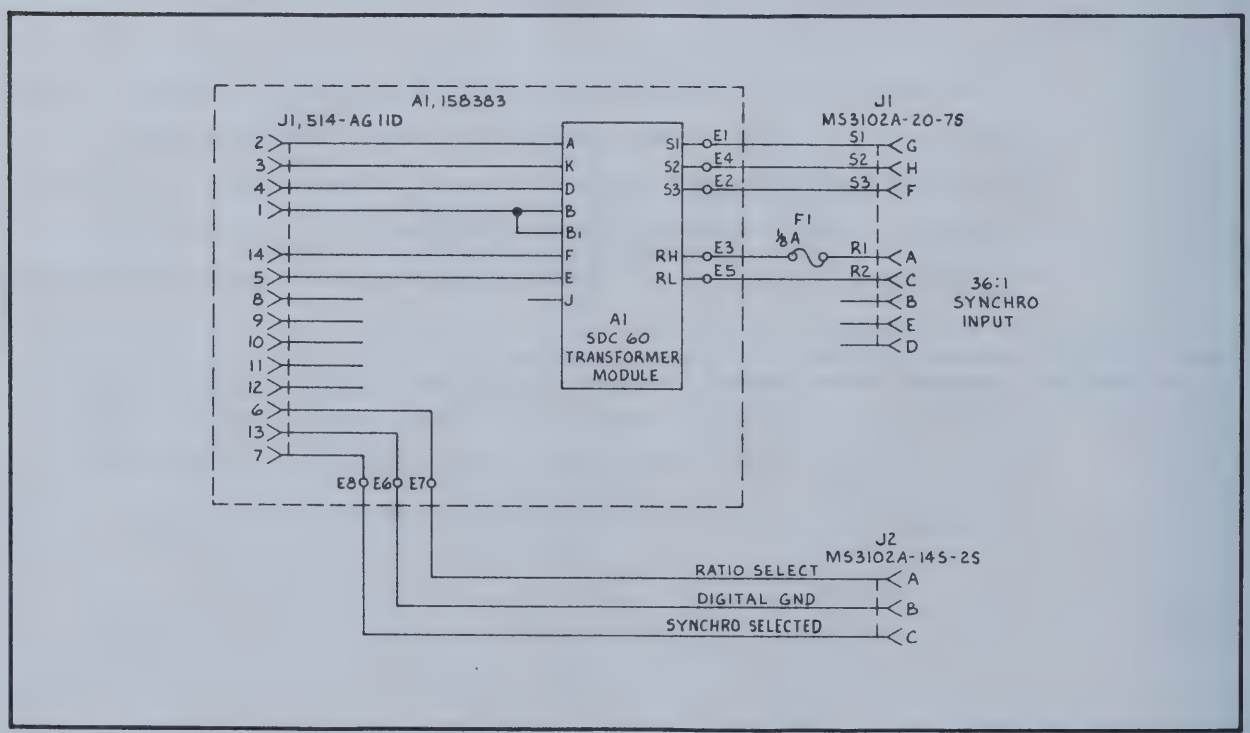


Figure 2-12. Synchro-to-Digital Transformer Assembly Schematic After Modification

CHAPTER 3
OPERATION

3.1 GENERAL

3.1.1 This chapter contains instructions for the initial start-up and general operation of the Series 1580 Pattern Recorder. It is recommended that operating personnel read this chapter thoroughly prior to operating the Series 1580 Pattern Recorder. While the equipment cannot be damaged by front panel control settings, an understanding of the control functions will reduce the time required to obtain valid data.

3.2 FRONT PANEL CONTROLS AND INDICATORS

3.2.1 A photograph illustrating the location of front panel controls and indicators for the Series 1580 Pattern Recorder is shown in Figure 3-1. These controls and indicators, as well as controls and indicators of auxiliary equipment, (i.e., Model 1586 Crystal Bolometer Amplifier, Model 1587 DC Amplifier, and Model 1588 Synchro Selector) should be fully understood prior to initiating a test so the resulting plot contains the information desired.

3.2.2 Once a test is started, an internal microprocessor analyzes and computes from input signals and plots an output graphic display automatically. An operator can stop a test at any time, change display and format parameters, but pen and chart functions are electronically controlled. The following list describes how the front panel controls affect operating parameters of the Series 1580 Pattern Recorder.

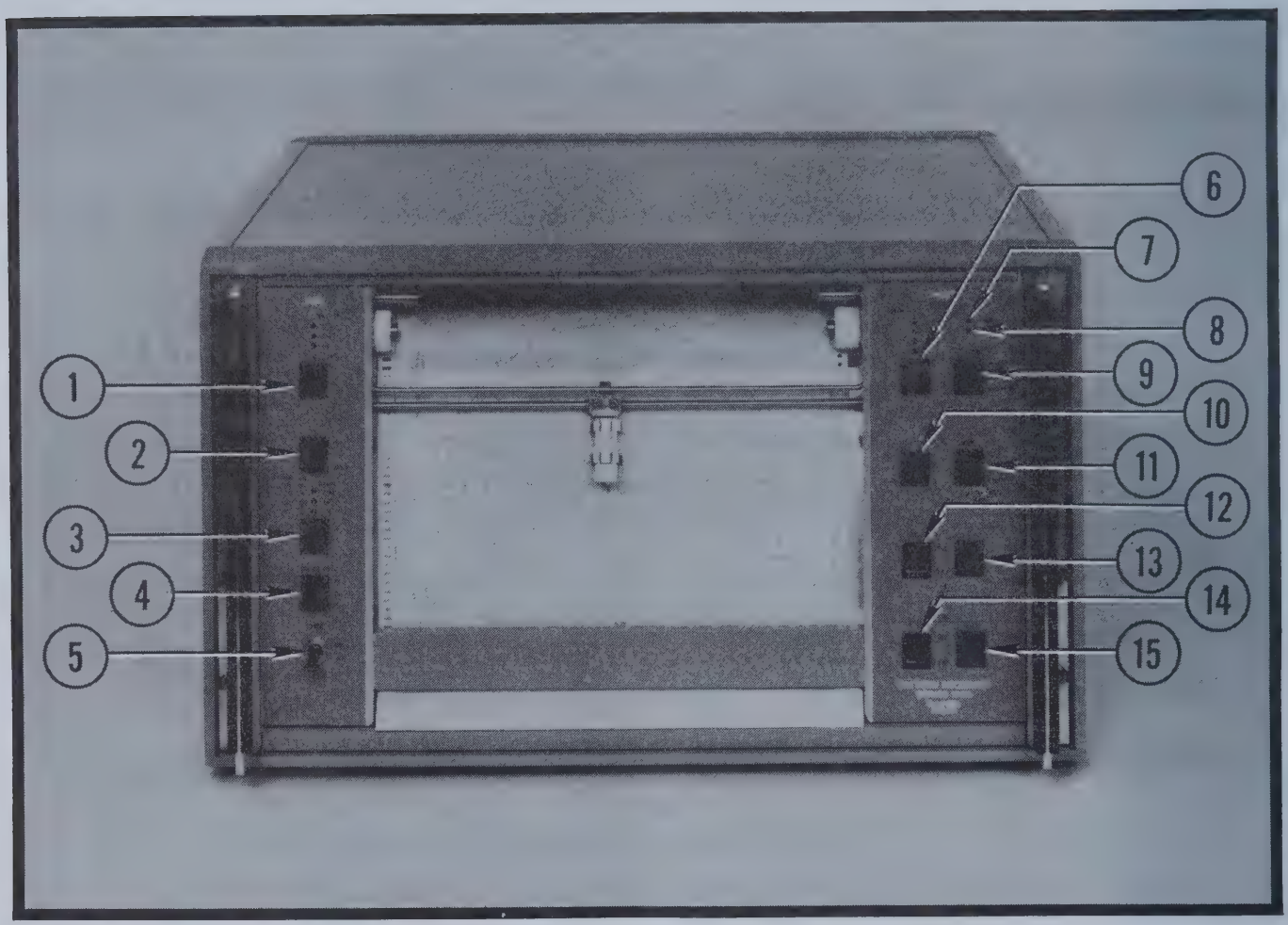


Figure 3-1. Front Panel Controls and Indicators

Table 3-1
Left Front Panel

Figure 3-1 Reference	Control Label	Control Function
1	PEN-FUNCTION Switch (LOG/LIN/SQ/ SQ RT)	A momentary pushbutton switch which sequences the Pen System circuits through the microprocessor where input signals are plotted as a function of the logarithmic, linear, square, or square root scales. An illuminated front panel indicator identifies which step of the sequence the Pen System will respond and function for.

Table 3-1 continued

Figure 3-1 Reference	Control Label	Control Function
2	PEN-(Operate Switch) OFF/LIFT/WRITE	A three position lever switch which controls the overall Pen System. In the OFF position, the Pen System will initialize the pen in the lifted position but will not allow tracking movement corresponding to input signals. The LIFT position allows the pen to follow a tracking movement while an operated cam tilts the marking pen away from the chart paper. The WRITE position repositions the cam to allow the marking pen to trace a permanent graph.
3	PEN-(Select recording range) SQ LAW dB / LIN dB / PHASE 40 / 80 / ±180° 20 / 40 / ±45° 10 / 20 / ±18°	A momentary pushbutton switch which sequences the recording range required from the microprocessor when driving the Pen System to full scale for Rectangular or Polar graphic plots. An illuminated front panel indicator identifies which step of the sequence the Pen System will respond and function for. The SQ LAW-dB recording range is normally used with a Square Law input signal (Square Law Detector). The LIN-dB recording range is normally used with a Linear input signal (Linear Detector). The PHASE recording range is normally used with the Series 1820 Phase Unit for plotting phase versus angles of the antenna.
4	PEN-OFFSET, dB Switch (40/20/0)	A three position lever switch that alters the Pen System by injecting a known calibrated

Table 3-1 continued

Figure 3-1 Reference	Control Label	Control Function
		offset to the input signal. This results in a modified plotted signal which can be better used to observe low level signals.
5	POWER ON/OFF Switch	A two position switch controlling the application of ac source voltage to the Series 1580 Pattern Recorder.
6	CHART-DEGREES Switch (360/90/18/9)	A momentary pushbutton switch which sequences the Chart System through the microprocessor and select the degrees per chart cycle. An illuminated front panel indicator identifies which step of the sequence the Chart System will respond to.
7	ERROR Indicator	Illuminates to alert the operator of the possibility of a recording error. This indicator is controlled through the microprocessor and is illuminated when signal format and memory format do not agree.
8	REMOTE Indicator	Illuminates to remind the operator when the Series 1580 Pattern Recorder is being remotely controlled through the functions of the IEEE-488 Interface bus.
9	SMOOTHING Switch (MAXIMUM/MEDIUM/ MINIMUM)	A three position lever switch that controls the amount of electronic smoothing to be applied to the input signal. This function provides an optimum pattern response in the presence of noise.

Table 3-1 continued

Figure 3-1 Reference	Control Label	Control Function
10	CHART-DIRECTION Switch (REV/OFF/FWD)	A three position lever switch that controls the direction of chart paper movement.
11	MODE Switch (FULL/HALF/POLAR)	A three position lever switch that signals the microprocessor as to which chart mode will be used. The microprocessor electronically conditions the input signal, the Pen System, and the Chart System according to the switch position.
12	CHART-SPACE Switch (REV/FWD)	A three position lever switch that will advance the chart paper in a desired direction and for only the distance between the horizontal limits of one chart display to the horizontal limits of the next chart display.
13	CHART-CYCLE Switch (REV/FWD)	A three position lever switch that will advance the chart paper in a desired direction and for only the distance between a referenced line of one chart display to the identical reference line of the next chart display.
14	CHART-ZERO FAST Switch (REV/FWD)	A three position lever switch that permits rapid advance of the chart paper.
15	CHART-ZERO SLOW Switch (REV/FWD)	A three position lever switch that permits small advancement of chart paper.

3.3 LOADING OF A CHART PAPER ROLL AND INITIAL CALIBRATION

3.3.1 The following pictorial sequence illustrates the steps necessary to load a chart paper roll into a Series 1580 Pattern Recorder. Calibration procedures are included and are necessary when changing between rectangular and polar plotting.

A. PRELIMINARY CONDITIONS

1. Front panel POWER ON-OFF switch to OFF.
2. A cap placed on the recorder pen tip to prevent accidental marking of the chart paper.

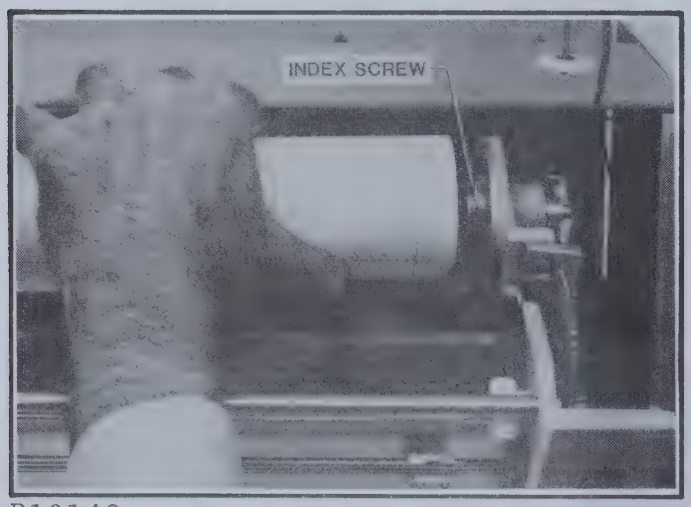
B. LOADING THE ROLL OF CHART PAPER

P10342

1. Pull out the recorder Head and lift the Idler Arm.

P10344

2. Hold the roll so paper comes from the top. Use the roll to push left end paper retainer against the frame assembly.

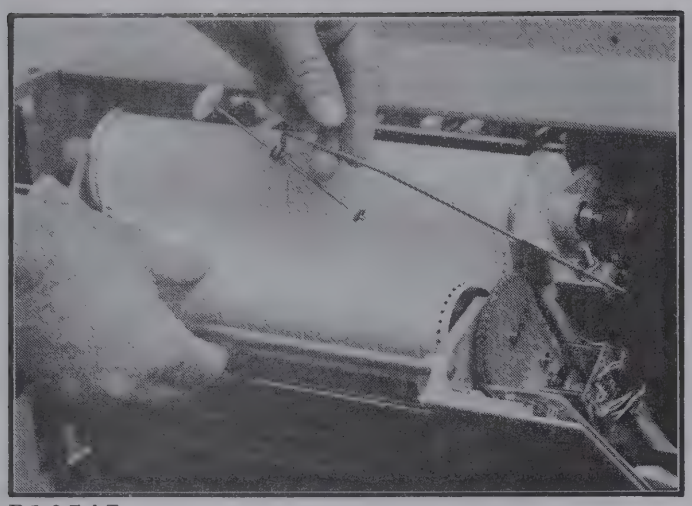


P10142

3. Rotate the drive gear until hub index screw is visable. Secure chart core on the hub. Rotate the chart paper roll until index screw engages slot in the chart paper core.

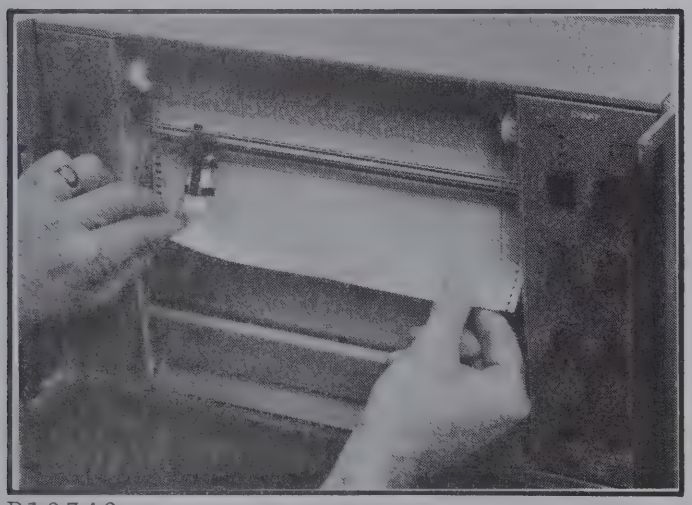
P10345

4. Align chart paper holes with drum sprocket at both ends. Route paper over drum while holding and providing gentle force to rotate the drum. Observe that the paper is straight from left to right during this threading procedure.



P10347

5. Thread paper about halfway down on the drawing surface. Observe the paper has been threaded straight (horizontal chart paper lines are straight compared to horizontal recorder members). Carefully drop idler arm onto the chart paper.

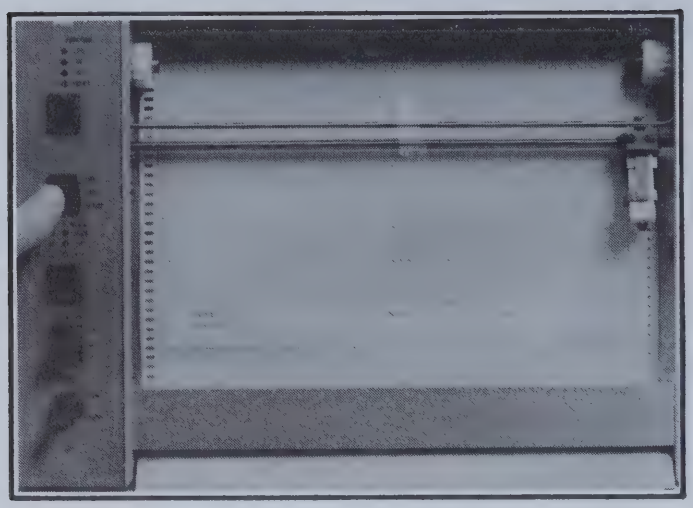


P10348

6. Close the recorder head assembly. Gently pull chart paper straight down. Observe that the paper is straight from left to right. Pull enough paper to meet the bottom bar.

P10332

7. Feed the paper behind the bar. Use fingertip pressure on the drawing surface to pull paper from the roll in a downward direction. A mechanical feed wheel may offer resistance to the paper path. Be patient. When the paper is past the bottom bar, use the other hand to pull the paper through.

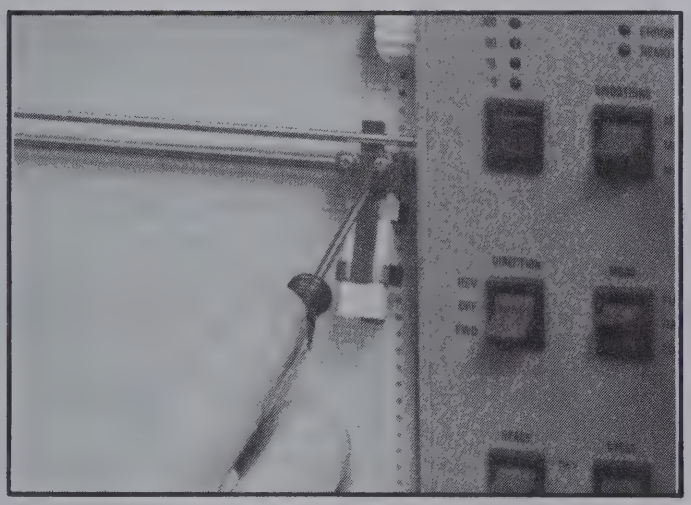


P10331

8. Be sure the PEN-OFF/LIFT/WRITE switch is in the OFF position and remains in the OFF position during the entire calibration procedure. Then operate the POWER ON/OFF switch to ON position. The pen assembly will be electronically driven to the far right side of the chart paper.

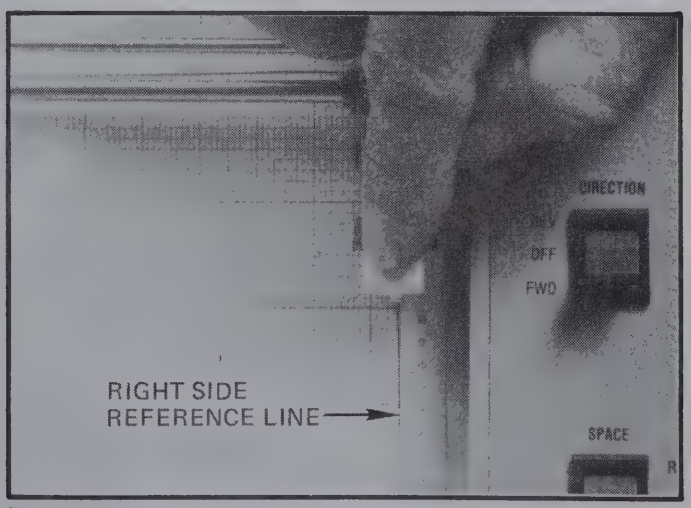
C. CALIBRATING TO RECTANGULAR CHART PAPER

1. For Polar Chart Paper Calibration, Use Procedures Listed Under D.
2. When changing paper and/or pens, calibration must be checked. Recalibration may be necessary.
3. The PEN-OFF/LIFT/WRITE switch must be OFF during calibration.



P10330

1. Remove the pen tip cap. Slightly loosen two pen assembly screws with a small Phillips screwdriver. Manually position pen point over the last grid line on the right side. Tighten the two screws.



P10329

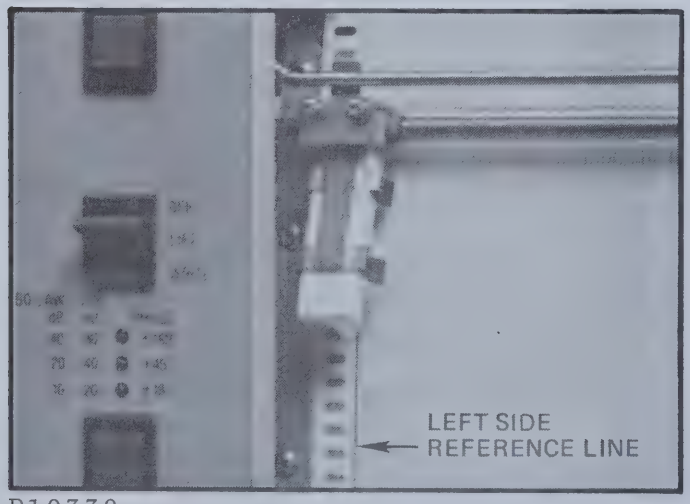
2. Manually cause the pen to mark the chart paper. If the mark is true, this step is complete. If the mark is off the grid line, repeat Steps 1 and 2 until the pen tip scribes a mark on the last grid line. Be sure the two pen assembly screws are securely tightened.

P10337

3. Pull the recorder head open. Locate the Pen Calibrate Assembly printed circuit board on the right hand side. Now locate the slide switch on the board. Slide the switch lever toward the back of the recorder. The pen assembly will electronically drive to the far left side of the chart paper.

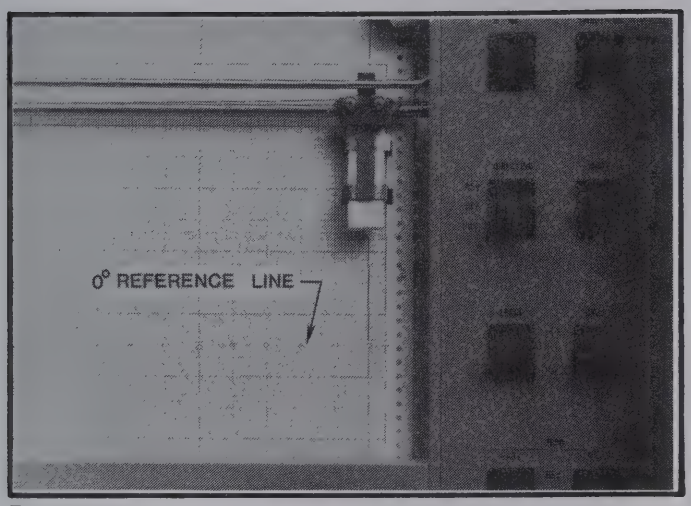
P10336

4. Use a small common screwdriver to adjust the digital rotary switches to center the pen over the last left grid line. Adjust between coarse and fine switches while observing the pen assembly position. Manually cause the pen to mark the chart paper. The adjustment is complete when the pen truely marks the last left grid line.



P10338

5. Close the recorder head assembly. Be careful of the idler arm. Recheck Step 4. Manually cause the pen assembly to mark while feeding a short length of chart paper. Feeding is accomplished by operating the ZERO-SLOW switch to either REV or FWD. If the mark centers on the left most line, this completes the electronic calibration. Pull the recorder head assembly open and reposition the slide switch operated in Step 3. The pen assembly will return to the right side of the chart paper.

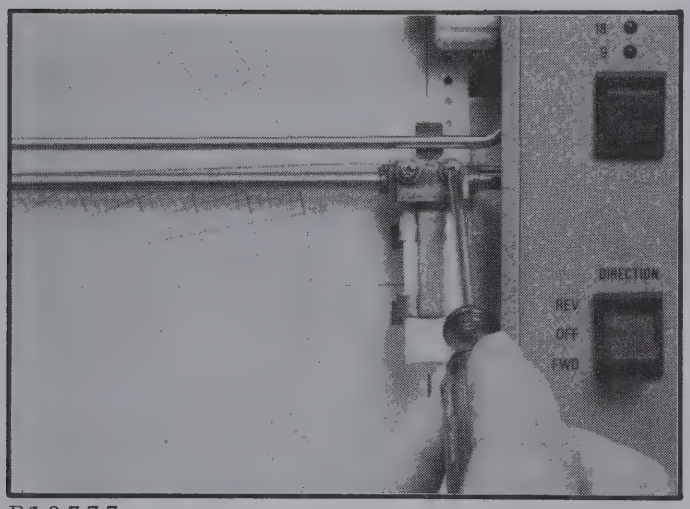


P10339

6. Operate the ZERO-SLOW switch to position the 0° chart line (centered on full scale/logarithmic chart paper) or 100% reference line (centered on half scale/linear) chart paper. The pen assembly will electronically locate in reference to the input signal. The illustration shows a 0 dB reference input signal. Operating the CYCLE switch will cause the recorder to advance to the center of the next chart graph if it is desired to start operation on an unmarked grid.

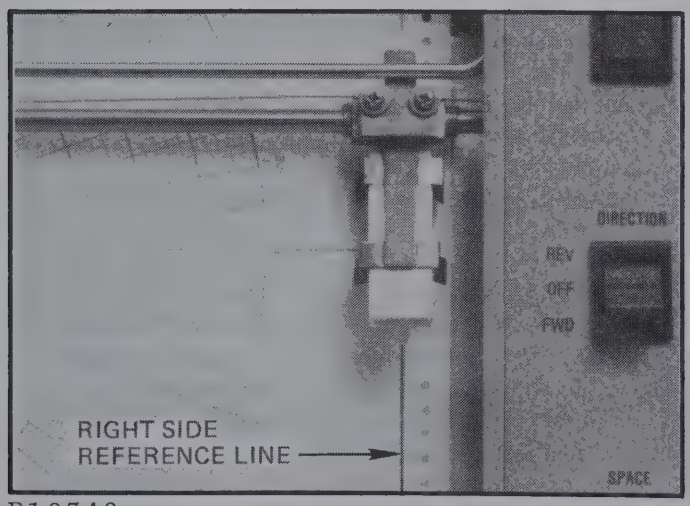
D. CALIBRATING TO POLAR CHART PAPER

1. For Rectangular Chart Paper Calibration, Use Procedures Listed Under C.
2. When changing paper and/or pens, calibration must be checked. Recalibration may be necessary.
3. The PEN-OFF/LIFT/WRITE switch must be OFF during calibration.



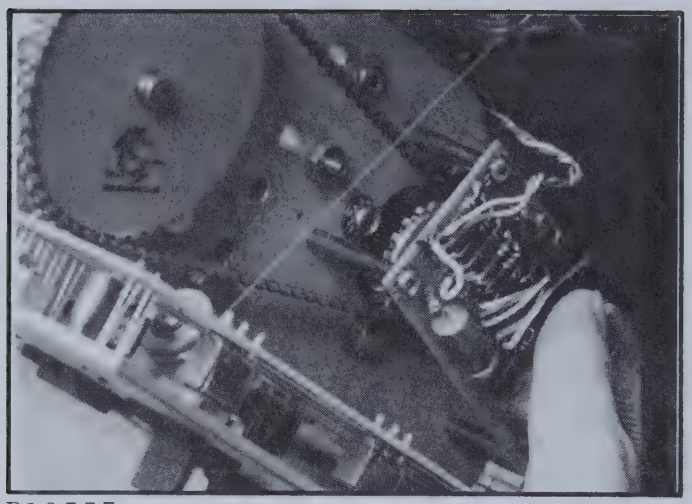
P10333

1. Remove the pen tip cap. Slightly loosen two pen assembly screws with a small Phillips screwdriver. Manually position pen point over the last grid line on the right side. Tighten the two screws.



P10340

2. Manually cause the pen to mark the chart paper. If the mark is true, this step is complete. If the mark is off the grid line, repeat Steps 1 and 2 until the pen tip scribes a mark on the last grid line. Be sure the two pen assembly screws are securely tightened.

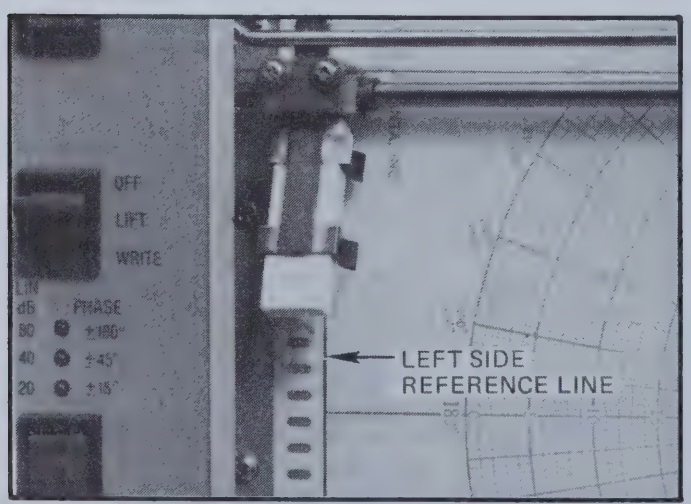


P10337

3. Pull the recorder head open. Locate the Pen Calibration Assembly printed circuit board on the right hand side. Now locate the slide switch on the board. Slide the switch lever toward the back of the recorder. The pen assembly will electronically drive to the far left side of the chart paper.

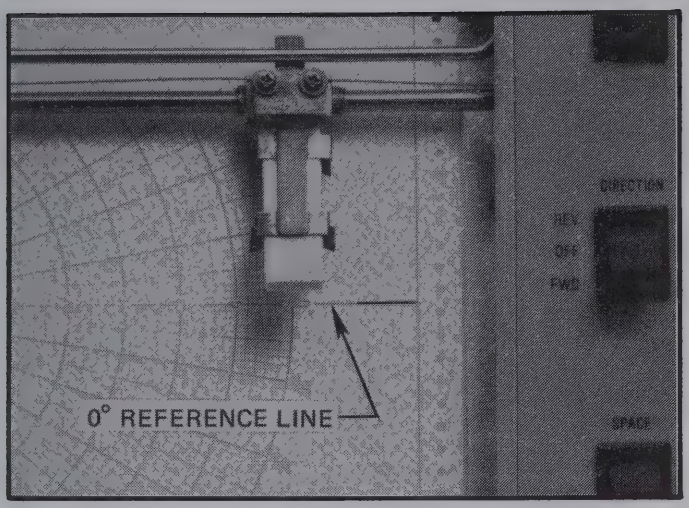
P10336

4. Use a small common screwdriver to adjust the digital rotary switches to center the pen over the last left grid line. Adjust between coarse and fine switches while observing the pen assembly position. Manually cause the pen to mark the chart paper. The adjustment is complete when the pen truely marks the last left grid line.



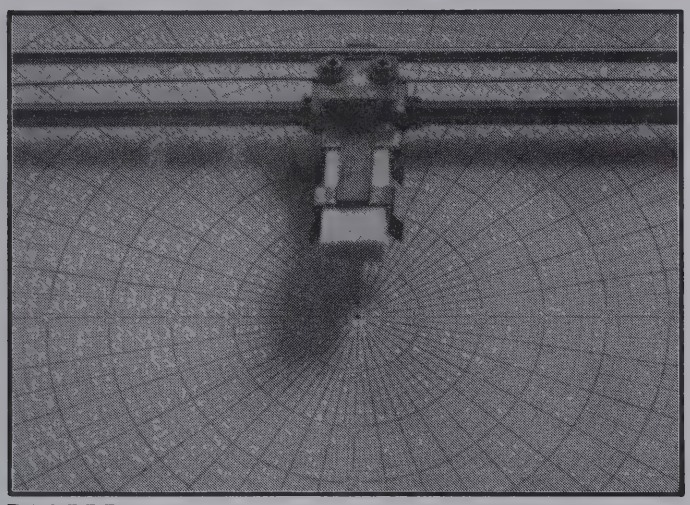
P10341

5. Close the recorder head assembly. Be careful of the idler arm. Recheck Step 4. Manually cause the pen assembly to mark while feeding a short length of chart paper. Feeding is accomplished by operating the ZERO-SLOW switch to either REV or FWD. If the mark centers on the left most line, this completes the electronic calibration. Pull the recorder head assembly open and reposition the slide switch operated in Step 3. The pen assembly will return to the right side of the chart paper.



P10334

6. Operate the ZERO-SLOW switch to position the 0° chart line under the pen point. The pen assembly will electronically locate in reference to the input signal. The illustration shows a 0 dB reference input signal. Operating the CYCLE switch will cause the recorder to advance to the center of the next chart graph if it is desired to start operation on an unmarked grid.



P10335

AUXILIARY TEST

7. If possible, disconnect the input signal. Proper calibration is evident when the pen assembly electronically centers on the polar graph paper. The pen tip should mark the precise center of the scale.

3.4 REMOTE OPERATION

A. REMOTE OPERATION CONDITIONING

3.4.1 The Series 1580 Pattern Recorder may be operated in a Remote Mode through the IEEE-488 Digital Interface Option. This option permits recorder front panel selection, as well as chart and pen position information, to be received from a remote controller (such as a digital computer) or from other instruments with a similar interface.

3.4.2 Two modes of operation are permitted with the IEEE-488 Digital Interface Option:

1. Full Remote Mode; where all front panel controls, plus chart and pen data, are received on the IEEE-488 bus.

   In this mode, a controller is required to establish the recorder as a listener and all front panel controls are disabled (locked out) from local operation. This mode allows the controller to select the source of chart and pen data to be the IEEE-488 bus, or from other recorder inputs.

2. Listen Only Mode; where the Series 1580 Pattern Recorder is selectively conditioned to be a listener only by internal switches.

   In this mode, a controller is not required and the front panel controls are optionally disabled. External input codes or internal switches permit selection of chart and pen data sources from either the IEEE-488 bus or from other recorder inputs.

B. CONTROL PANEL PROGRAMMING

3.4.3 With the exception of the front panel PEN SMOOTHING and MANUAL CHART ZERO-FAST/SLOW controls, all Series 1580 Pattern Recorder front panel controls may be operated by remotely generated commands transmitted on the IEEE-488 Digital Interface Bus. Some additional commands (not present as front panel controls) are available for remote operation. The operator should reference Table 3-1 for a full description of the front panel controls.

3.4.4 Each command consists of two ASCII characters which must be transmitted in series. The first character identifies the command and the second character specifies the command position. Consecutive commands (or pairs of ASCII characters) may or may not be separated by delimiters [a comma (,) or a semicolon (;)]. Imbedded spaces are not permitted.

3.4.5 Each command received by the recorder is examined for validity. Invalid commands are ignored (or not acted upon) but cause the front panel ERROR indicator to illuminate. The error indicated will be cleared when the next valid command is received.

3.4.6 Front panel controls and the equivalent ASCII coded commands for both pen and chart functions are listed below. (Note that the CHART-ZERO function is not programmable.)

1. PEN-FUNCTION
   - LOG = U1
   - LIN = U2
   - SQ (Square) = U3
   - SQ RT (Square Root) = U4

2. PEN-SQ LAW/LIN/PHASE (Scale)
   - 10/20/±18° = K1
   - 20/40/±45° = K2
   - 40/80/±180° = K3

3. PEN-OFFSET, dB
   0 dB = N0
   20 dB = N1
   40 dB - N2

4. PEN-(Status)
   WRITE = W0 (pen down with pen motion)
   LIFT = W1 (pen up with pen motion)
   OFF = W2 (pen up with no pen motion)

5. CHART-DEGREES (Scale)
   360 = C1
   90 = C2
   18 = C3
   9 = C4

6 CHART-MODE (Size)
   HALF = L0
   FULL = L1
   POLAR = L2

7. CHART-DIRECTION
   OFF = D0
   REV = D1
   FWD = D2

8. CHART-CYCLE
   (Midposition) = B0
   REV = B1
   FWD = B2

9. CHART-SPACE
   (Midposition) = J0
   REV = J1
   FWD = J2

10. Copy "LOCAL" front panel to "REMOTE" front panel. (Refer to "D. LISTEN ONLY MODE" operations described in this chapter.

C. ADDITIONAL COMMANDS

3.4.7 Data Input Selection. The listed commands identify selections permitted to both pen and chart data inputs from either the IEEE-488 Interface or from other optional pen and chart equipment. Some optional equipment which may be currently installed and interfaced with the Series 1580 Pattern Recorder include the CBA option for the pen function and/or the Synchro-to-Digital (S/D) Converter option for the chart function.

COMMAND	PEN INPUT	CHART INPUT
T0	Pen Interface	Chart Interface
T1	Pen Interface	IEEE-488 Interface
T2	IEEE-488 Interface	Chart Interface
T3	IEEE-488 Interface	IEEE-488 Interface

3.4.8 Real Time Selection. These two commands cause the pen and chart input data to be specified in either "real time" or in "non-real time".

3.4.8.1 Selecting the "real time" mode causes the pen and/or chart data to be processed by the recorder as received. Operation in this mode permits no requests for data by the recorder. Should incoming data rates exceed the recorder processing speed, the excess data will not be processed.

3.4.8.2 Selecting the "non-real time" mode requires both chart and pen data to be received as a data "pair" before either is plotted. Synchronization is maintained by the controller which always provides a data "pair". Data should be transmitted chart data, then pen data. Receipt of chart data causes any previously received pen data to be discarded by the recorder. The recorder will operate on "chart", then "pen" data pairs. The recorder requests data from the controller by setting bit 1 of the Serial Poll Register and generating a service request by enabling the SRQ line.

3.4.8.3 In the "non-real time" mode, additional vectoring may be performed by the recorder using pen and chart input data. Errors in the pen and chart position error are monitored and must have diminished below specific values before requests for additional data are made.

Commands for these features are:

X0 = non-real time
X1 = real time

3.4.9 Parallel Poll Configuration. The Series 1580 Pattern Recorder, when operating with the IEEE-488 Interface Option, does not permit direct configuration of Parallel Poll response. The following list of commands show how the system will configure the Parallel Poll response using an indirect method. The specific bit will be "set" when the Parallel Poll is initiated by the system controller.

COMMAND	BIT DESIGNATION
G1	Bit 1
G2	Bit 2
G3	Bit 3
G4	Bit 4
G5	Bit 5
G6	Bit 6
G7	Bit 7
G8	Bit 8

3.4.10 Device Clear and Selected Device Clear. The controller, when necessary, may cause the IEEE-488 bus to set the commands Device Clear (DC) or Selected Device Clear (SDC). These commands will cause the recorder to default to the following modes:

1. PEN-FUNCTION = LOG
2. PEN-SCALE = 40/80/±180°
3. PEN-OFFSET = 0 dB (Normal)
4. PEN-(Solenoid) = LIFT (Pen lifted with motion)
5. CHART-(Scale) = 360 DEGREES

6. CHART-MODE = FULL
7. CHART-CYCLE = No Selection (Off)
8. CHART-SPACE = No Selection (Off)
9. CHART-DIRECTION = FWD
10. Data Input Selection Table = Pen Interface/Chart Interface
11. Non-real Time

3.4.11 Serial Poll Register. The Serial Poll Register is normally set as follows:

Bit 1 - True = Data Request
Bit 2 - True = Low Paper Supply
Bit 3 - True = Paper Edge Sense
Bit 4 - True = Recorder Idle

3.4.11.1 Data Request. Recorder is ready to accept additional chart and pen data into buffer storage. A one data point (chart and pen) storage is provided to permit receipt of new data in parallel while processing (by recorder) of last data point.

3.4.11.2 Low Paper Supply. Indicates chart supply roll is near depletion. The operator should install a new chart paper roll.

3.4.11.3 Paper Edge Sense. Indicates recorder has detected the paper edge at the front panel. An Automatic Chart Forward signal will occur to advance chart paper as required.

3.4.11.4 Recorder Idle. Recorder has no chart or pen data to process, i.e., recorder is idle with no chart or pen data available.

NOTE

The contents of the Serial Poll Register applies to the status of the recorder with respect to chart and pen data only. No status feedback is available for Pen Lift, Chart Cycle, Chart Space, or other front panel controls.

D. LISTEN ONLY MODE

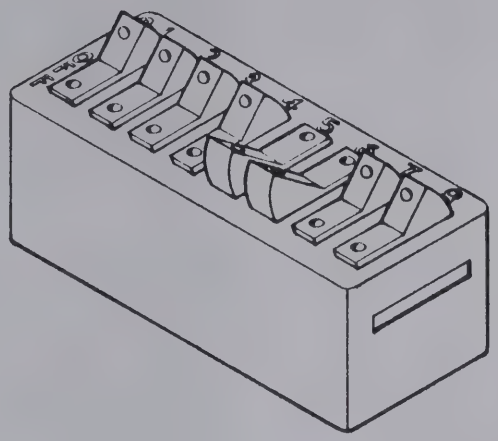
3.4.12 The Listen Only Mode allows the Series 1580 Pattern Recorder to monitor the IEEE-488 Interface without being addressed by a controller. This mode is selected by setting Bit 8 of the Address Switch assembly to "ON". This switch assembly is located in the upper left corner of the IEEE-488 Interface printed circuit board (A3A7) and is illustrated in Figure 3-2. The Listen Only Mode is disabled when the Bit 8 switch is positioned to "OFF".

E. PEN/CHART INPUT SELECT FOR LISTEN ONLY MODE

3.4.13 Selection of the pen and chart data inputs is controlled by Bits 7 and 6, respectively, of the Address Switch assembly illustrated in Figure 3-2. The switch enables the respective circuit to receive input data through either the IEEE-488 Interface bus or through existing pen or chart interface capability as noted below:

Bit 7 - ON = Pen data will be received through the IEEE-488 Interface bus.

Bit 7 - OFF = Pen data will not be provided through the IEEE-488 Interface bus. The pen circuits will receive pen data through either the CBA or BCD Interface options.



SWITCH POSITION	ADDRESS SWITCH FUNCTIONS
1	IEEE-488 Bus Addresses
2	
3	
4	
5	
6	Chart Data
7	Pen Data
8	Listen Only

Figure 3-2. DIP Switch Address Selection Through IEEE-488 Printed Circuit Board (A3A7)

Bit 6 - ON = Chart data will be received through the IEEE-488 Interface bus.

Bit 6 - OFF = Chart data will not be provided through the IEEE-488 Interface bus. The chart circuits will receive chart data through either the S/D (Synchro-to-Digital) or BCD Interface options.

NOTE

If both Bit 6 and Bit 7 are set to OFF, no chart or pen data will be received on the IEEE-488 bus. Talkers with the capability of transmitting the commands described in paragraph 3.3.7 may then select the desired data input modes.

F. FRONT PANEL CONTROL FOR LISTEN ONLY MODE

3.4.15 Normally the Listen Only mode operates with the front panel in "LOCAL" and the operator must perform front panel selections as needed. For Talkers capable of transmitting front panel setup commands, capability is provided to allow remote operation of the front panel in the Listen Only mode.

Y2 = Transfer the present "local front panel setup" to "remote panel setup". This will permit switching to "remote" without disturbing the front panel.

Y1 = Switch front panel operation from "local" to "remote". The front panel REMOTE indicator will illuminate and the recorder will respond to front panel control inputs from a Talker. All commands described in paragraphs 3.3.6, 3.3.7, and 3.3.8 are applicable.

Y0 = Return to "local". The front panel controls will be returned to local operation and to previous local positions. The front panel REMOTE indicator will be de-energized.

G. HOLD OFF FOR LISTEN ONLY MODE

3.4.15 To permit the recorder to completely process chart and pen data pairs before accepting additional data, a Hold Off command is provided. Chart and pen data items must be transmitted in pairs (i.e., chart data, then pen data, etc.). When the Hold Off command is enabled, the bus is prevented from handshaking on the last pen data byte received. When both chart data and pen data have been processed, and the chart/pen position errors have diminished to near zero, handshaking can be completed. Additional chart data and pen data may then be transmitted by the Talker.

Q0 = Disable Hold Off
Q1 = Enable Hold Off

H. INSTALLATION PROCEDURE FOR THE LISTEN ONLY MODE

3.4.16 The following procedure can be used to install the Listen Only Mode of operation into the Series 1580 Pattern Recorder.

1. Remove ac power from the Series 1580 Pattern Recorder.
2. Remove the cover from the Data Processor Subassembly card cage.
3. Remove the IEEE-488 Interface printed circuit board (A3A7).
4. Set the Address switches (detailed in Figure 3-2) as desired. For the Listen Only Mode, set switch 8 to ON and switches 6 and 7 as desired (see paragraph 3.4.13).

5. Return the IEEE-488 Interface printed circuit board to its original location and seat it securely in the mating connector.
6. Replace and secure the Data Processor Subassembly card cage cover.
7. Restore ac power and continue with normal operation.

3.5 DATA FORMATS

3.5.1 Both pen and chart data inputs are described in this section. All alpha characters are ASCII format and all numerals are ASCII BCD format. The following notes are applicable to the data formats used specifically in the Series 1580 Pattern Recorder.

1. Plus sign characters may be replaced with a space character.
2. There can be no embedded spaces between sign characters and numeric field characters.
3. There can be no embedded spaces in the numeric field.
4. There can be no trailing spaces after the numeric field.
5. String delimiters must be a comma (,) or semicolon (;).
6. Block delimiters may be Carriage Return and Line Feed characters.
7. Record delimiters may be END or DAB (EOI, End of Information, or last data byte).

A.PEN DATA FORMAT

3.5.2 There are three types of data which may be input to the Series 1580 Pattern Recorder pen system through the IEEE-488 Interface bus. These inputs are:

1. Amplitude Data
2. Phase Data
3. Absolute Pen Position Data

The format description for each input is provided in the following tables.

Table 3-2
Amplitude Data, 0.1 Resolution

Position Character	ASCII Character	Character Meaning
1	A	Identifies Amplitude Data. This character is examined by the recorder.
2	(A, B, or C)	Identifies amplitude channel. This character is not examined by the recorder but a character must be present as a space holder.
3	(G, H, L)	Over-range character. This character is not examined by the recorder but a character must be present as a space holder. A character space is not permitted.
4	(+ or -)	Sign character. This character is examined by the recorder.
5	n_1	Most significant data character (10^2), ASCII-numeric Ø through 9.
6	n_2	Next least significant data character (10^1), ASCII-numeric Ø through 9.
7	n_3	Next least significant data character (10^0), ASCII-numeric Ø through 9.
8	.	Decimal character. This character must be present.
9	n_4	Least significant data character (10^{-1}), ASCII-numeric Ø through 9.

Table 3-3
Amplitude Data, 0.01 Resolution

Character Position	ASCII Character	Character Meaning
1	A	Identifies Amplitude Data. This character is examined by the recorder.
2	(A, B, or C)	Identifies amplitude channel. This character is not examined by the recorder but a character must be present as a space holder.
3	(G, H, L)	Over-range character. This character is not examined by the recorder but a character must be present as a space holder. A character space is not permitted.
4	(+ or -)	Sign character. This character is examined by the recorder circuits.
5	n_1	Most significant data character (10^1), ASCII-numeric Ø through 9.
6	n_2	Next least significant data character (10^0), ASCII-numeric Ø through 9.
7	.	Decimal character. This character must be present.
8	n_3	Next least significant data character (10^{-1}), ASCII-numeric Ø through 9.
9	n_4	Least significant data character (10^{-2}), ASCII-numeric Ø through 9.

Table 3-4
Phase Data

Position	ASCII Character	Character Meaning
1	P	Identifies Phase Data. This character is examined by the recorder.
2	(A, B)	Identifies the receiver channel. This character is not examined by the recorder but a character must be present as a space holder. A character space is not permitted.
3	(G, H, L)	Invalid data character. This character is not examined by the recorder but a character must be present as a space holder. A character space is not permitted.
4	(+ or -)	Sign character. This character is examined by the recorder circuits.
5	n_1	Most significant data character (10^2), ASCII-numeric Ø through 3.
6	n_2	Next least significant data character (10^1), ASCII-numeric Ø through 9.
7	n_3	Next least significant data character (10^0), ASCII-numeric Ø through 9.
8	.	Decimal character. This character must be present.
9	n_4	Least significant data character (10^{-1}), ASCII-numeric Ø through 9.

NOTE: Phase data may be input in Modulo 0-360.0 or 0+-180.0 degrees only.

Table 3-5
Absolute Pen Data

Position	ASCII Character	Character Meaning
1	V	Identifies absolute pen position. This character is examined by the recorder circuits.
2	n_1	Most significant data character (10^3), ASCII-numeric Ø through 4.
3	n_2	Next least significant data character (10^2), ASCII-numeric Ø through 9.
4	n_3	Next least significant data character (10^1), ASCII-numeric Ø through 9.
5	n_4	Least significant data character (10^0), ASCII-numeric Ø through 9.

NOTE: 1. Absolute pen data must be in the range of 0 to 4100. When Ø represents the extreme pen position on the right side of the chart paper and 4100 represents the extreme pen position on the left side of the chart paper.

2. Absolute pen data inputs bypass all recorder pen functions and is not recommended for Polar Operation.

3. Pen resolution is 16.66 counts per millimeter.

B. CHART DATA FORMAT

3.5.3 There are two types of data which may be input to the Series 1580 Pattern Recorder chart system through the IEEE-488 Interface bus. These inputs are:

1. Angular Chart Data
2. Delta Chart Data

The format description for each input is provided in the following tables:

Tabel 3-6
Angular Chart Data
0.001 Degrees Resolution

Character Position	ASCII Character	Character Meaning
1	S	Identifies angular chart data. This character is examined by the recorder.
2	(A, L)	Angular or linear data flag character. This character is not examined by the recorder but a character must be present as a space holder. A character space is not permitted.
3	(+ or -)	Sign character. This character is examined by the recorder.
4	n_1	Most significant data character (10^2), ASCII-numeric Ø through 9.
5	n_2	Next least significant data character (10^1), ASCII-numeric Ø through 9.
6	n_3	Next least significant data character (10^0), ASCII-numeric Ø through 9.
7	.	Decimal character. This character must be present.
8	n_4	Next least significant data character (10^{-1}), ASCII-numeric Ø through 9.
9	n_5	Next least significant data character (10^{-2}), ASCII-numeric Ø through 9.
10	n_6	Next least significant data character (10^{-3}), ASCII-numeric Ø through 9.
11	n_7	Least signicant data character (10^{-4}), ASCII-numeric Ø through 9.

NOTE: Angular Chart Data may be Modulo 0+-999.9999.

Table 3-7
Data Chart Data

Character Position	ASCII Character	Character Meaning
1	H	Identifies Delta Chart data input. This character is examined by the recorder circuits.
2	(+ or -)	Sign character. This character is examined by the recorder circuits.
3	n_1	Most significant data character (10^3), ASCII-numeric Ø through 9.
4	n_2	Next least significant data character (10^2), ASCII-numeric Ø through 9.
5	n_3	Next least significant data character (10^1), ASCII-numeric Ø through 9.
6	n_4	Least significant data character (10^0), ASCII-numeric Ø through 9.

NOTE: Chart resolution is 17.77 counts per millimeter.

CHAPTER 4
THEORY OF OPERATION

4.1 GENERAL

4.1.1 Each part of the theory of operation for the Series 1580 Pattern Recorder is started with a block diagram analysis of the equipment to be covered. Simplified circuit diagrams are included where possible to provide a better understanding of circuit operation. Also, each part of the theory of operation is presented according to signal flow regardless of any circuit layout designation. The diagrams provided in Chapter 7 are arranged in alphanumeric sequence without regard to signal flow.

4.1.2 The descriptions presented in this chapter are arranged to provide an overall understanding of the complex and interrelated functions necessary for the operation of the Series 1580 Pattern Recorder. First, the power supply sources are described (paragraph 4.2), then the normal digital functions (paragraphs 4.3 through 4.9), and then the optional digital functions (paragraphs 4.10 through 4.14).

4.2 THE POWER SUPPLY SOURCES

4.2.1 The applied line voltage of 115 volts or 230 volts, 50 to 60 Hz, is applied through the power cord (Part No. 82801) to the rear panel Line Filter, Voltage Select, and Fuse Block unit (JFL-1). The position of the voltage select printed circuit board and the proper value of fuse (F1) in the JFL-1 unit permits normal operation with either applied line voltage. One side of the ac

line (commonly referred to as "hot") is interrupted by the front panel POWER-ON switch to provide operator control of the Series 1580 Pattern Recorder.

4.2.2 When the "hot" side of the applied ac voltage is completed, proper distribution to the primary windings of transformer A2T1 is provided through contacts on the JFL-1 printed circuit board. If the JFL-1 printed circuit board is positioned correctly with relation to the applied ac input voltage, then proper operating voltage of 115 volts ac is also provided to energize the cooling fan B1, rewind motors, and the pen lift solenoid.

4.2.3 Three secondary windings of transformer A2T1 provide the required stepped down voltages for the different supply sources necessary for normal operation of the Series 1580 Pattern Recorder. The supply sources provide operating voltages of (1) ±15 volts dc, (2), ±5 volts dc, (3) +12 volts dc, and (3) ±26 volts dc. (See Figure 4-1.)

A. ±15 VOLT DC SUPPLY SOURCES

4.2.4 Transformer windings at terminals 8, 9, and 10 provide approximately 38 volts center tapped ac which is applied to the diode bridge A2CR1 for full wave rectification. A positive rectified voltage is applied across filter capacitor A2C1 and series regulator transistor A2Q1 to the voltage regulator LM 305A (A1U1) on the Voltage Regulator printed circuit board (A2A1). The voltage is applied to the regulator circuit through connector A2A1J1, pins E, F, and D, and is a positive potential in reference to the transformer winding center tap (terminal 9). This center tap is the reference for both positive and negative sources and connects to the regulator circuits through adjacent pins A,1 and B,2 of connector A2A1J1.

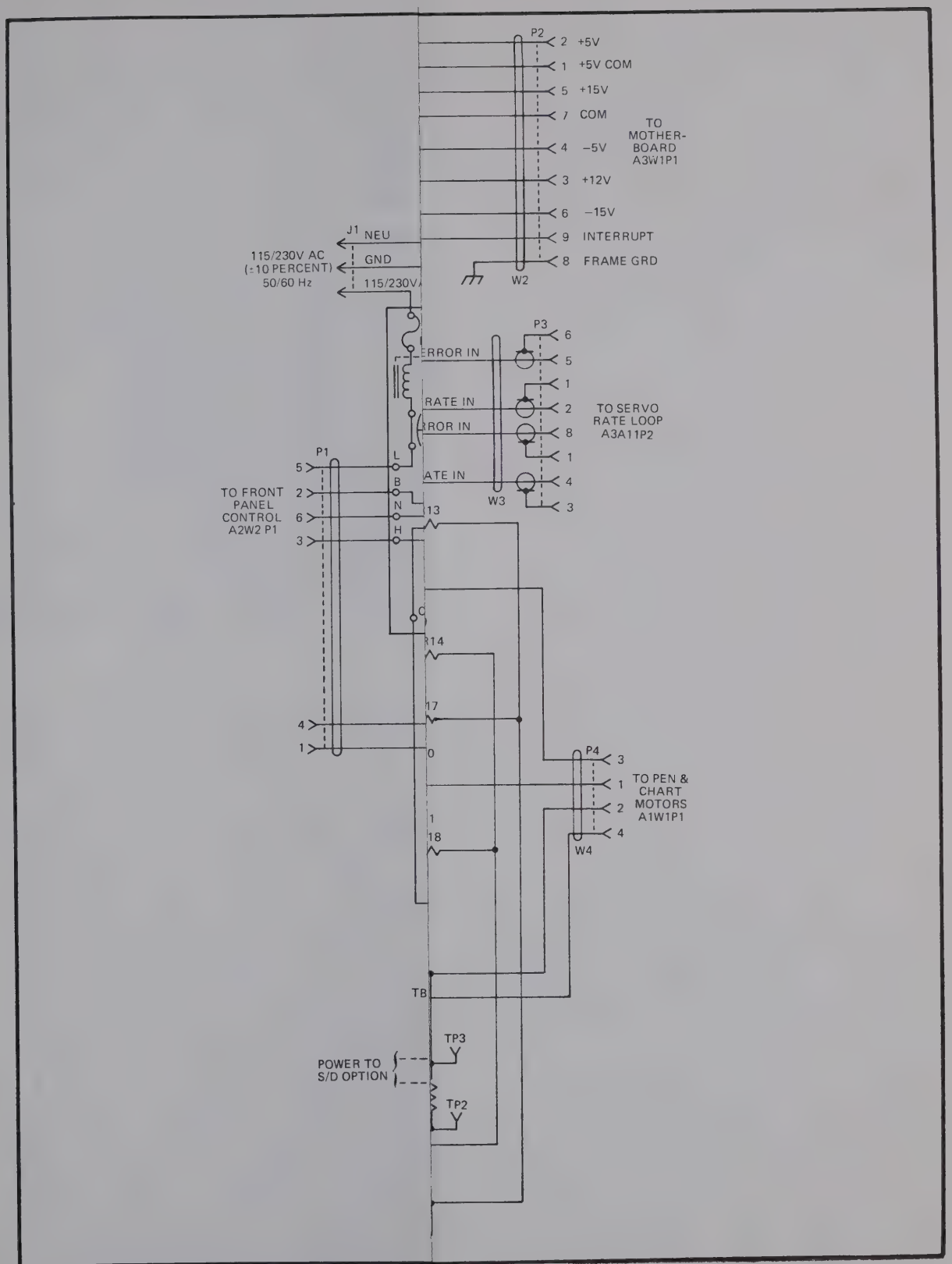


Figure 4-1. Power Supply Assembly (A2), Simplified Schematic

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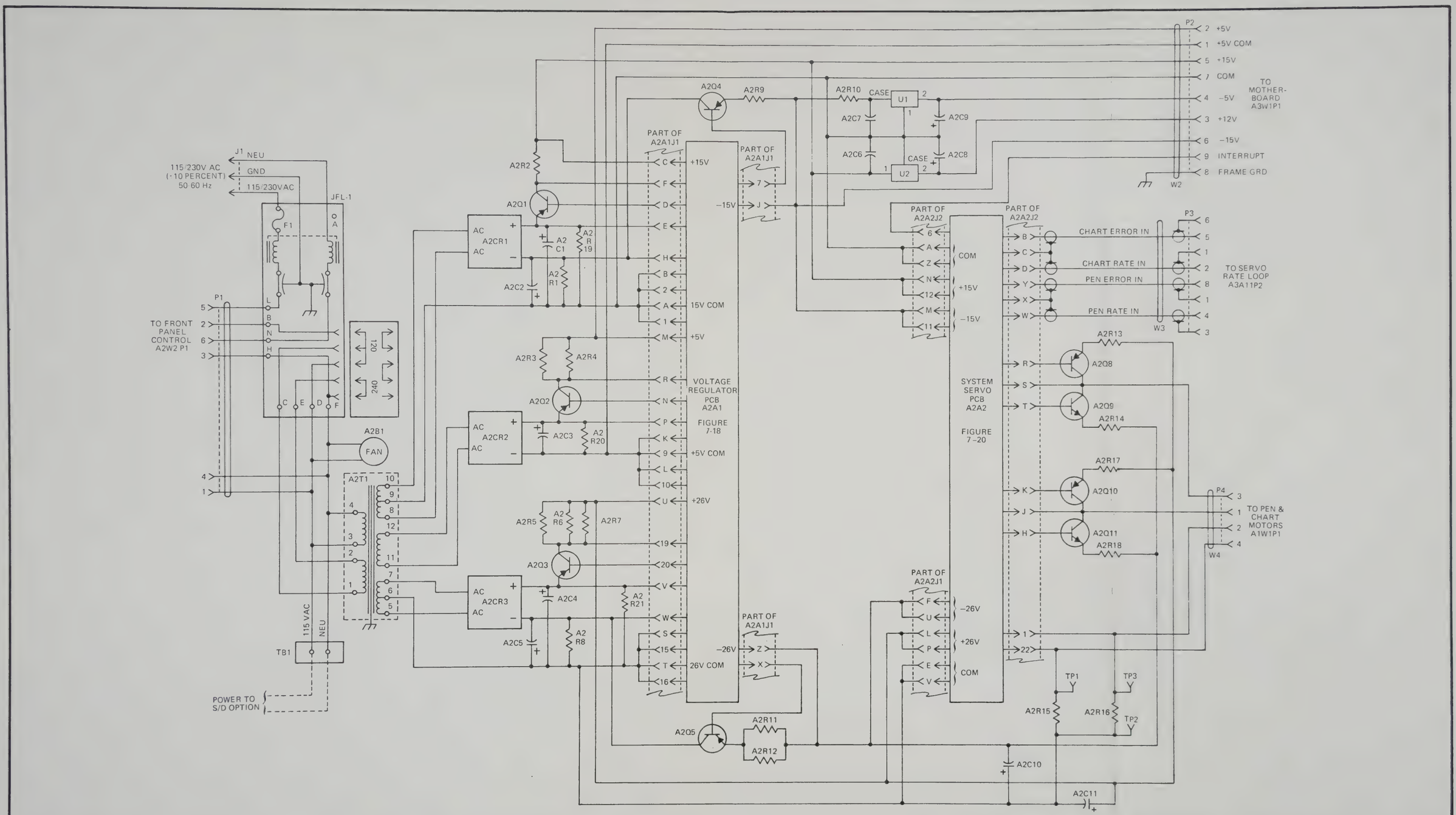

Figure 4-1. Power Supply Assembly (A2), Simplified Schematic

4.2.5 Components used with voltage regulator A1U1 are arranged to provide a well filtered adjustable +15 volt source. Changes in the output voltage will be sensed on the feedback input at A1U1, pin 6, which in turn changes the output level at pin 2. Pin 2 effectively controls the operation of transistor A2Q1 which in turn controls the voltage input level to the regulator on pin 1. Variable resistor A1R4 sets the desired output voltage level which can be monitored using test points TP1 and TP2. Resistors A2R2 and A2A1R2 provide current fold-back in the event of a short circuit or system malfunction. Once the current fold-back feature is triggered, the cause must be located and corrected. The fold-back feature will be reset each time the power supply reenergized after being switched off. The positive 15 volt dc output is distributed to other Series 1580 Pattern Recorder circuits through connector A2A1J1, pin C, such as the Servo System printed circuit board (A2A2) shown in Figure 4-2 for an example.

4.2.6 The negative source from rectifier A2CR1 is filtered by capacitor A2C2 and applied to the LM 304A voltage regulator (A1U2) through connector A2A1J1, pin H. This regulated source operates similar to the positive regulated source but with necessary complimentary differences. One obvious difference is that the source input is adjusted rather than the source output. The voltage established by variable resistor A1R9 equals the voltage appearing across resistor A1R13. Any variation in the preset voltage level is sensed and corrected by transistor A1Q1. This voltage level can be measured and/or monitored using test points TP3 and TP2 (common). Transistor A1Q1, with resistors A1R8, A1R10, and A2R9, provide a complimentary current fold-back feature similar to the current fold-back components used in the positive 15 volt dc supply. The negative 15 volt dc output is distributed to other Series 1580 Pattern Recorder circuits through connector A2A1J1, pin J, such as the Servo System printed circuit board (A2A2) shown in Figure 4-1 for example.

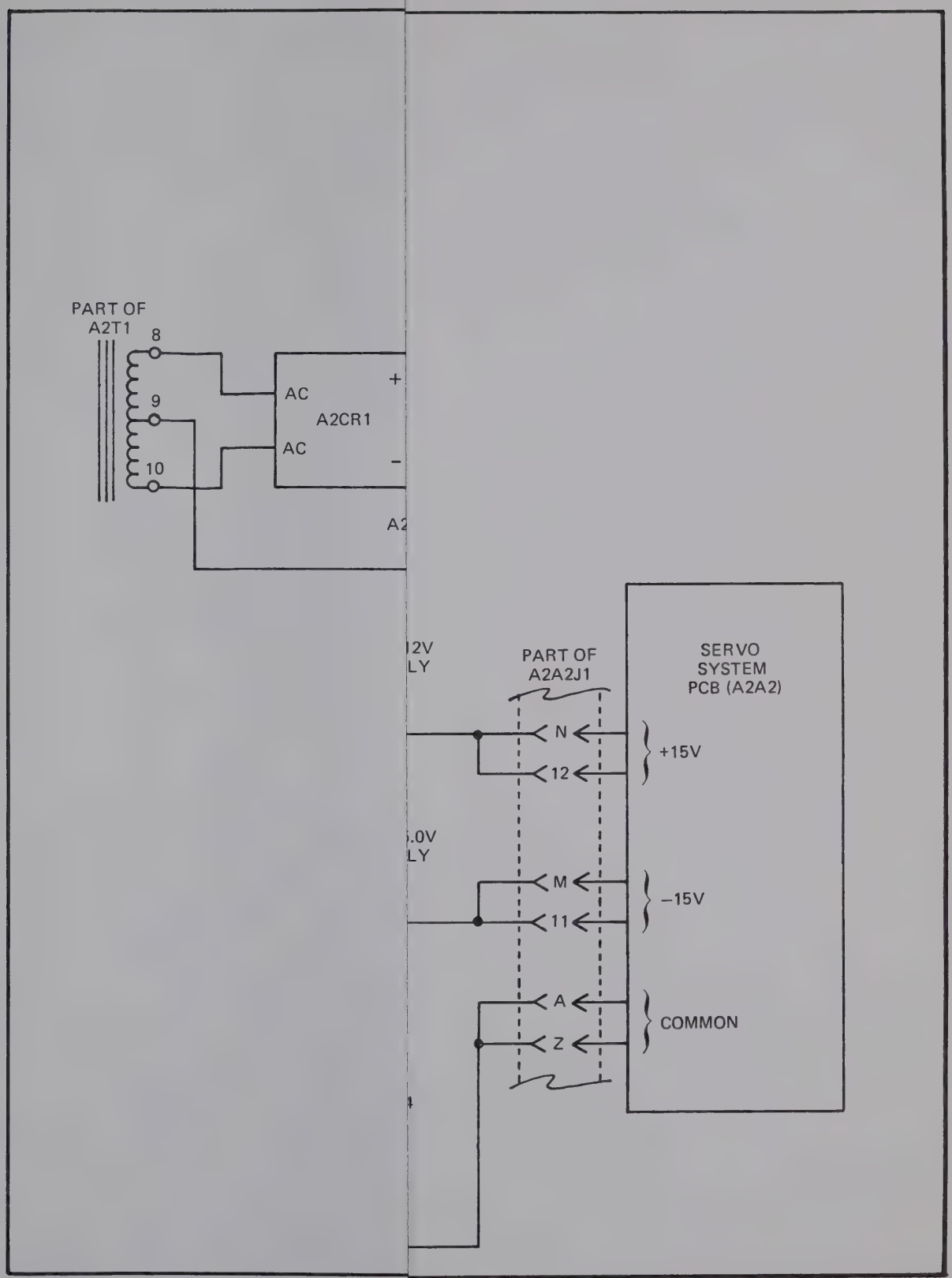

Figure 4-2. Power Supply Assembly (A2), ±15 Volt DC Supply Sources, Simplified Schematic

4.2.5 Components used with voltage regulator A1U1 are arranged to provide a well filtered adjustable +15 volt source. Changes in the output voltage will be sensed on the feedback input at A1U1, pin 6, which in turn changes the output level at pin 2. Pin 2 effectively controls the operation of transistor A2Q1 which in turn controls the voltage input level to the regulator on pin 1. Variable resistor A1R4 sets the desired output voltage level which can be monitored using test points TP1 and TP2. Resistors A2R2 and A2A1R2 provide current fold-back in the event of a short circuit or system malfunction. Once the current fold-back feature is triggered, the cause must be located and corrected. The fold-back feature will be reset each time the power supply reenergized after being switched off. The positive 15 volt dc output is distributed to other Series 1580 Pattern Recorder circuits through connector A2A1J1, pin C, such as the Servo System printed circuit board (A2A2) shown in Figure 4-2 for an example.

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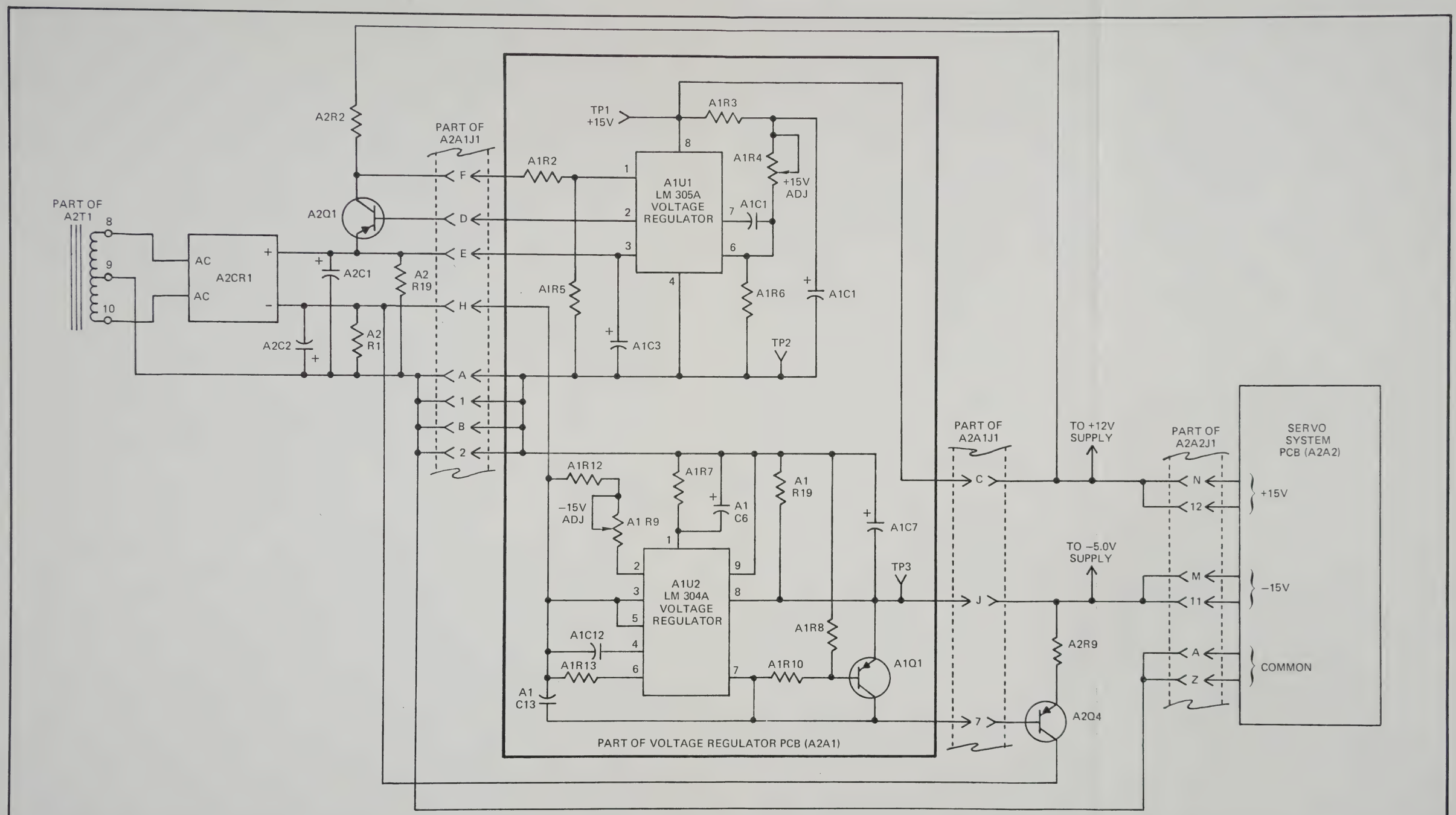


Figure 4-2. Power Supply Assembly (A2), ±15 Volt DC Supply Sources, Simplified Schematic

B. –5 VOLT DC, +12 VOLT DC SUPPLY SOURCES

4.2.7 The regulated -15 volt dc source supply from the Voltage Regulator printed circuit board (A2A1) is monitored and electronically adjusted as a constant current source by transistor A2Q4 and resistor A2R9. (See Figure 4-3.) A portion of the -15 volt supply is routed to resistor A2R10 and applied to the fixed voltage regulator A2U1. The regulator internally compensated for over-current protection which is reset each time the power supply circuits are energized after being switched off. Capacitors A2C7 and A2C9 provide filtering as necessary.

4.2.8 Similarly, the +15 volt dc source supply is routed to a fixed voltage regulator A1U2 as shown in Figure 4-3. The circuit provides similar internal compensation for over-current and reset capability. Capacitors A2C6 and A2C8 provide filtering as necessary.

C. +5.0 VOLT DC SUPPLY SOURCE

4.2.9 Transformer winding at terminals 11 and 12 provide approximately 9 volts ac which is applied to the diode bridge A2CR2 (see Figure 4-4). The rectified output is applied across filter capacitor A2C3 and series regulator transistor A2Q2 to the LM 305A voltage regulator (A1U3) on the Voltage Regulator printed circuit board (A2A1). Components used with the voltage regulator (A1U3) are arranged to provide a well filtered adjustable voltage source. Changes in the output voltage will be sensed on the feedback input at A1U3, pin 6, which in turn changes the output level at pin 2. Pin 2 effectively controls the operation of transistor A2Q2 which, in turn, controls the voltage input level to the regulator on pin 1. Variable resistor A1R16 sets the desired output voltage level which can be monitored using test points TP4 and TP5. The +5 volt dc output is distributed to other Series 1580 Pattern Recorder circuits through

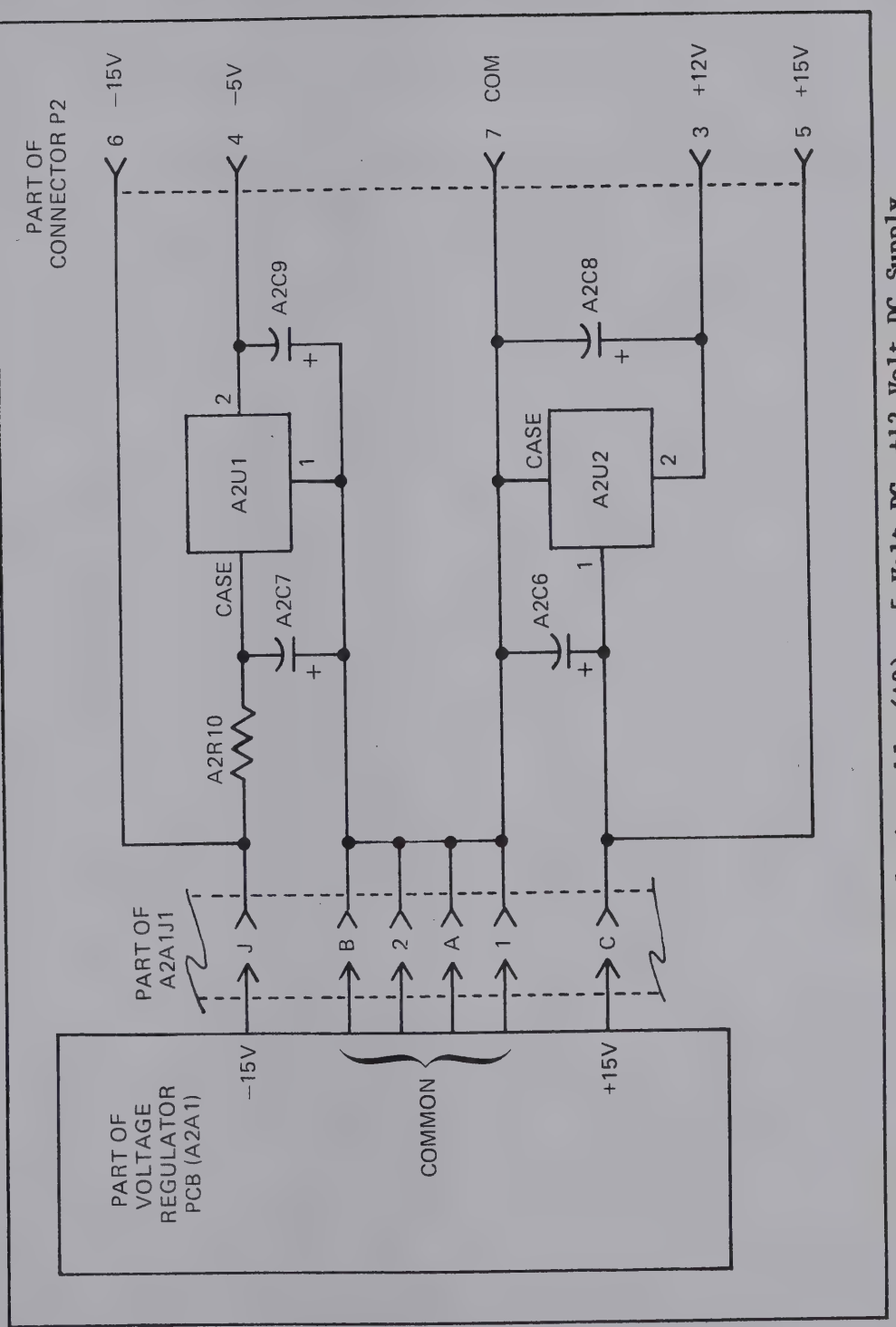


Figure 4-3. Power Supply Assembly (A2), -5 Volt DC, +12 Volt DC Supply Sources, Simplified Schematic

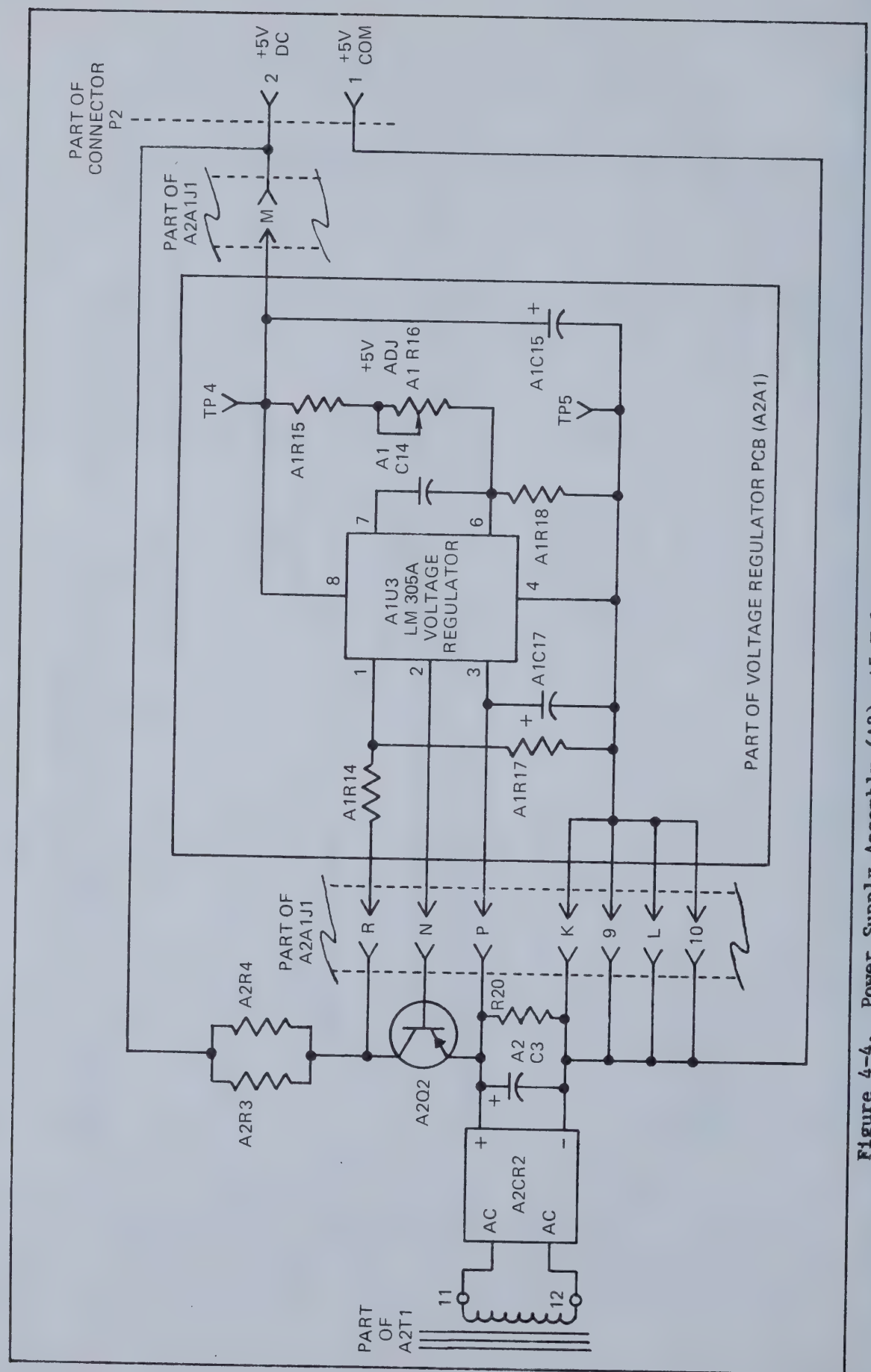


Figure 4-4. Power Supply Assembly (A2), ±5 Volt DC Supply Source, Simplified Schematic

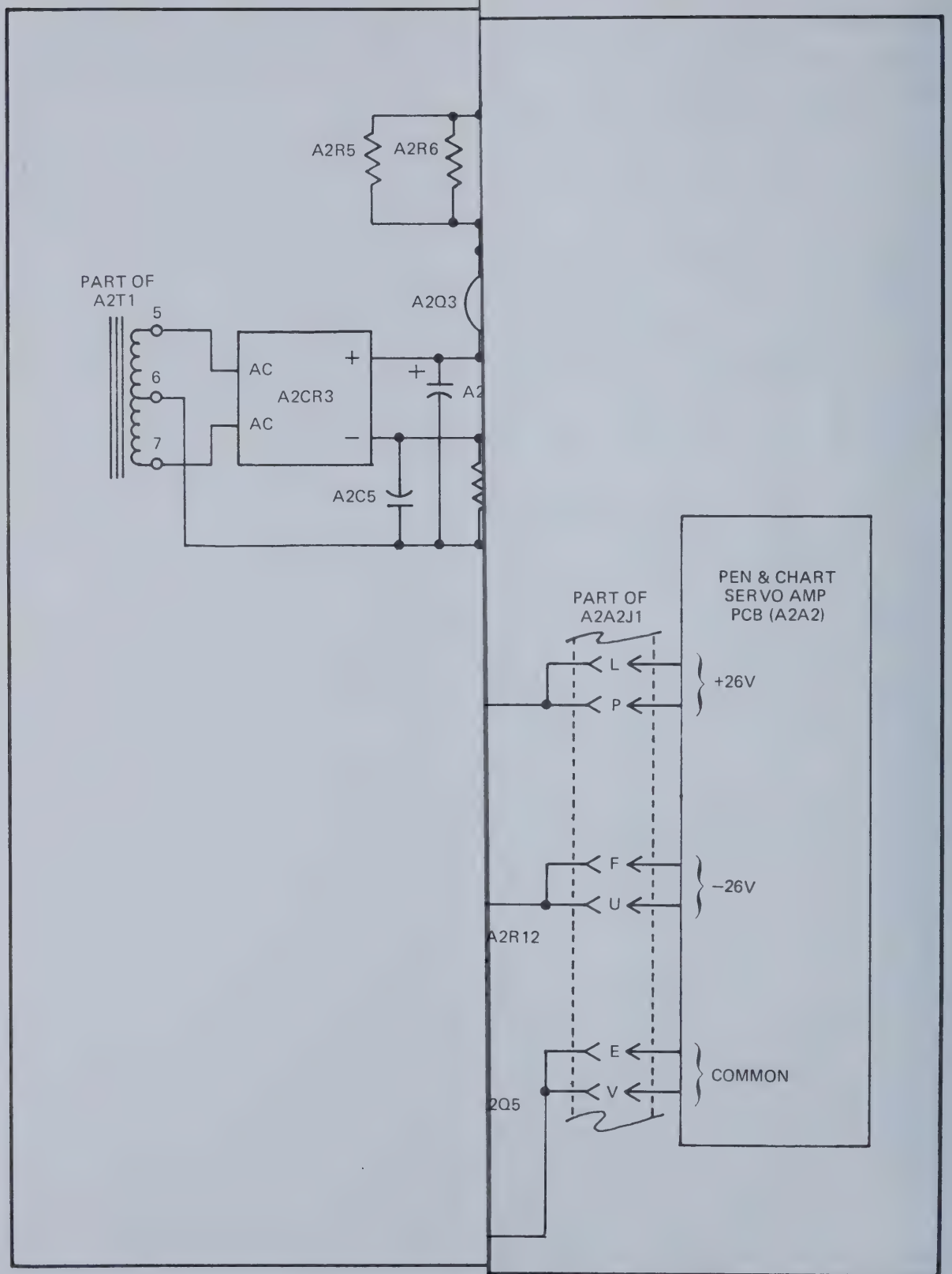
connector A2A1J1, pin M, and to connector P2. Resistors A2R3, A2R4, and A2A1R14 provide a similar current fold-back feature as described for the ±15 volt dc supply sources.

D.±26 VOLT DC SUPPLY SOURCES

4.2.10 The Series 1580 Pattern Recorder Servo System requires symetrical ±26 volt dc sources to accurately position the pen and chart functions in relation to input commands. The ±26 volt dc sources shown in Figure 4-5 are very similar to the operation of the ±15 volt dc sources with the difference being defined by the components and values used.

4.2.11 Transformer windings at terminals 5, 6, and 7 provide approximately 60 volts center tapped ac which is applied to the diode bridge A2CR3 for full wave rectification. A positive rectified voltage is applied across capacitor A2C4 and series regulator transistor A2Q3 to the voltage regulator LM 305A (A1U4) on the Voltage Regulator printed circuit board (A2A1). The voltage is applied to the regulator circuit through connector A2A1J1, pins V,19 and 20, and is a positive potential in reference to the transformer center tap (terminal 6). This center tap is the reference for both positive and negative sources and connects to the regulator circuits through adjacent pins S,15 and T,16 of connector A2A1J1.

4.2.12 Components used with the voltage regulator A1U4 are arranged to provide a well filtered adjustable +26 volt source. Changes in the output voltage will be sensed on the feedback input at A1U4, pin 6, which in turn changes the output level at pin 2. Pin 2 effectively controls the operation of transistor A2Q3, which in turn, controls the voltage input level to the regulator on pin 1. Variable resistor A1R24 sets the desired output voltage which can be monitored using test points TP6 and TP7. The positive 26 volt dc output is distributed to



ure 4-5. **Power Supply Assembly (A2), ±26 Volt DC Supply Sources, Simplified Schematic**

both the Servo Motor Drive circuits and Servo System printed circuit board (A2A2) through connector A2A1J1, pin U. Two resistors, A2R6 and A2R7, are provided in the collector circuit of transistor A2Q3 for current sensing requirements of the current fold-back feature which is similar to the circuit described in the positive 15 volt dc supply source.

4.2.13 The negative source from rectifier A2CR3 is filtered by capacitor A2C5 and applied to the LM 104 voltage regulator (A1U5) through connector A2A1J1, pin W. This regulated source operates similar to the positive regulated source but with the necessary complimentary differences. One obvious difference is that the source input is adjusted rather than the source output. The voltage established by variable resistor A1R31 equals the voltage appearing across resistor A1R27. Any variation in the preset voltage level is sensed and corrected by transistor A1Q2. This voltage level can be measured using test points TP8 and TP7 (common). The negative 26 volt dc output is distributed to both the Servo Motor Drive circuits and Servo System printed circuit board (A2A2) through connector A2A1J1, pin Z. Transistor A2A1Q2 and resistors A1R29, A1R30, A2R11, and A2R12 are arranged to provide current sensing requirements for the complimentary current feedback feature similar to the circuit in the negative 15 volt dc supply source.

4.3 THE DIGITAL DATA PROCESSOR CIRCUITS

A. GENERAL

4.3.1 The Model 1581 Pattern Recorder is controlled by a 16-bit microprocessor. This microprocessor is responsible for performing all logic manipulations involving operation interface, external equipment interface, chart scaling mathematics, pen function (position) mathematics, and providing servo loop control for both pen and chart drive systems.

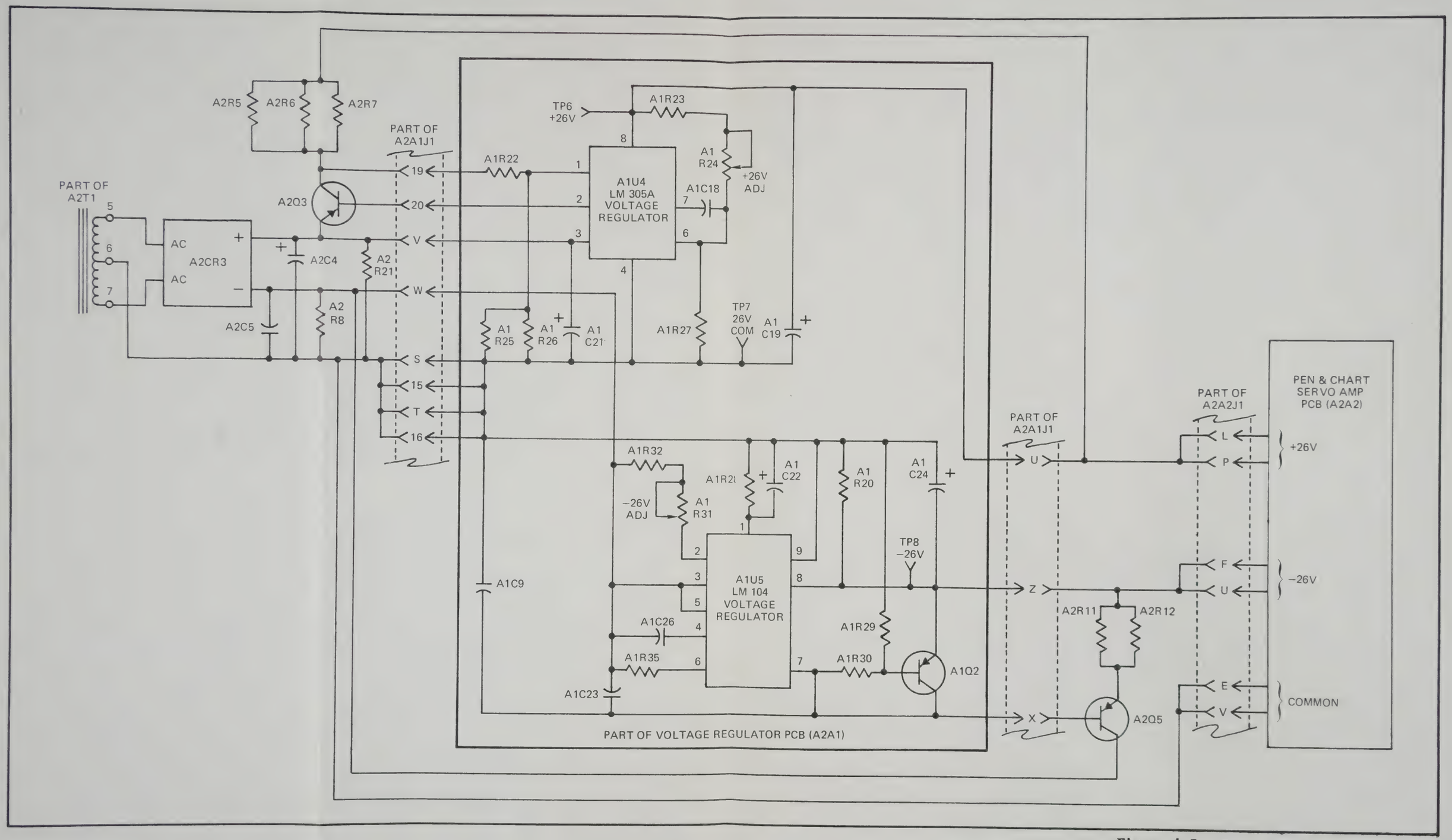


Figure 4-5. Power Supply Assembly (A2), ±26 Volt DC Supply Sources, Simplified Schematic

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4.3.2 Block diagrams shown in Figures 4-6, 4-7, and 4-8 show the Model 1581 Pattern Recorder using three levels of complexity. Figure 4-6 illustrates the basic digital recorder while Figure 4-7 adds important details. Figure 4-8 shows all the functional modules used in the Model 1581 Pattern Recorder. Each block diagram is described to provide a basic understanding of the functional modules. After the block diagram descriptions, a detailed description for each module is provided, using pertinent block diagrams where necessary, to assist in understanding the interrelationships between modules and the microprocessor.

4.3.3 As the overall block diagrams are described, keep in mind that a "control" program has been stored in the microprocessor memory. It is this program that performs the functions as described. Note also that the "functions" are performed by the microprocessor in serial format, i.e., as the program is executed, one function is performed completely, then the next function, and the next, etc., until the End-of-Program is reached. At the End-of-Program, a loop is made back to the Top-of-Program and proceeds. This "loop" begins with the "Power-Up" sequence and "loops" continuously.

4.3.4 The block diagram shown in Figure 4-6 shows the Model 1581 Pattern Recorder in the most basic form. A microprocessor and a memory form the central control element for all actions and functions.

4.3.5 Front panel operator selections are monitored directly by the microprocessor. Since the front panel switches and indicators are interfaced to this computer-type function, each program loop provides the microprocessor an opportunity to examine switch positions and to update status indicators. When an operator changes a switch position to select a particular operation, the microprocessor will note the change and perform the requested operation.

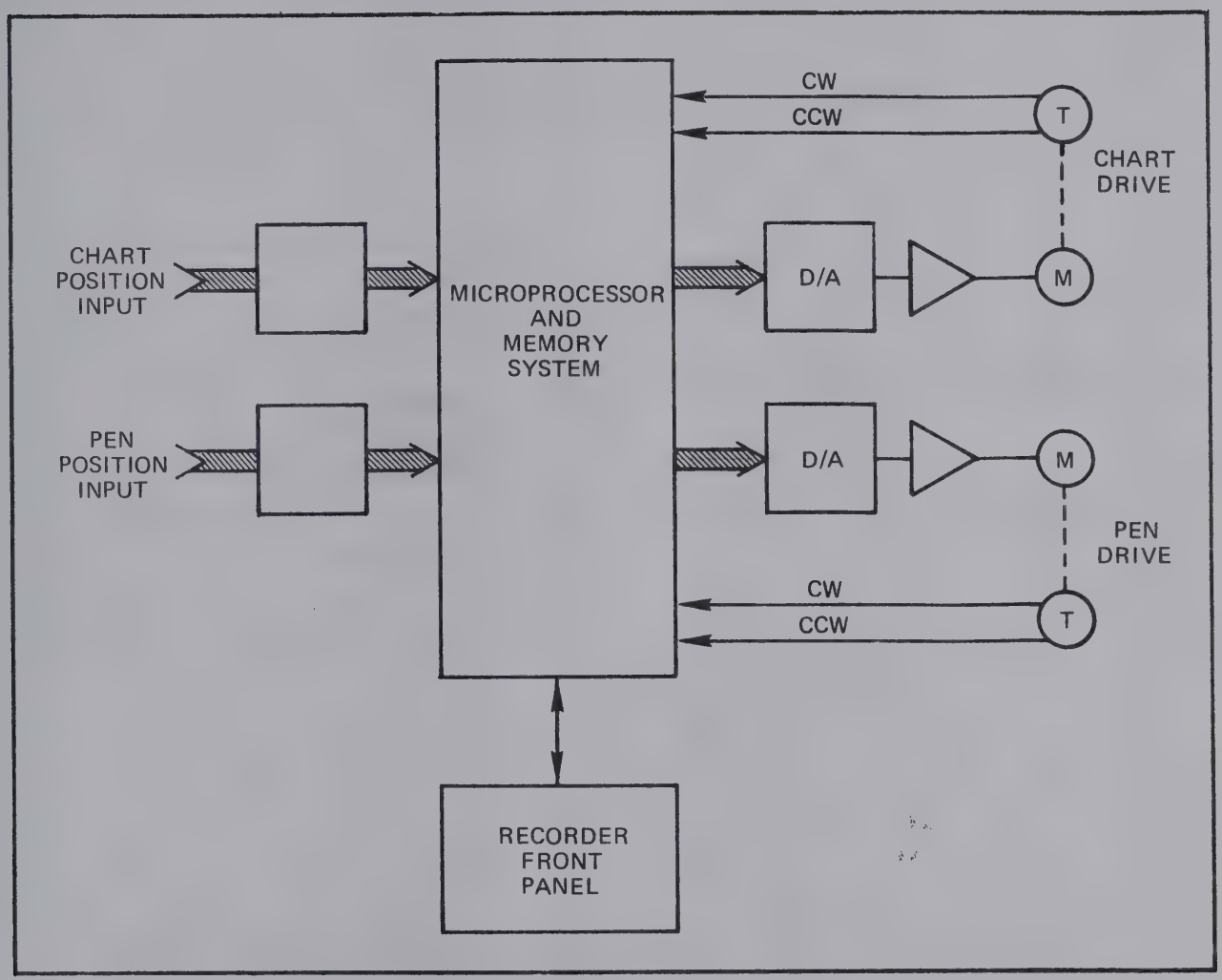


Figure 4-6. Digital Data Processor Circuits, Simplified Block Diagram

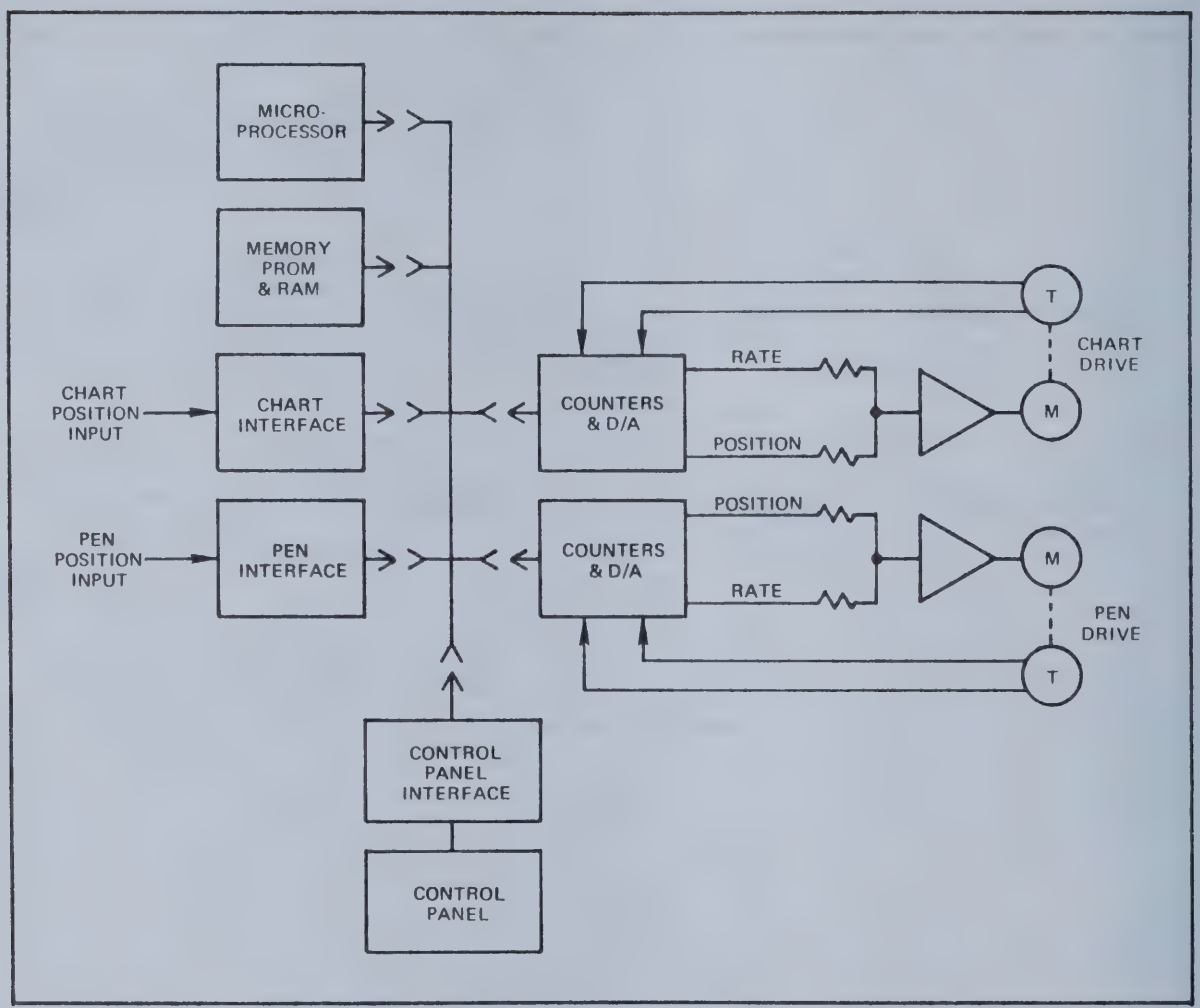


Figure 4-7. Digital Data Bus Routing, Simplified Block Diagram

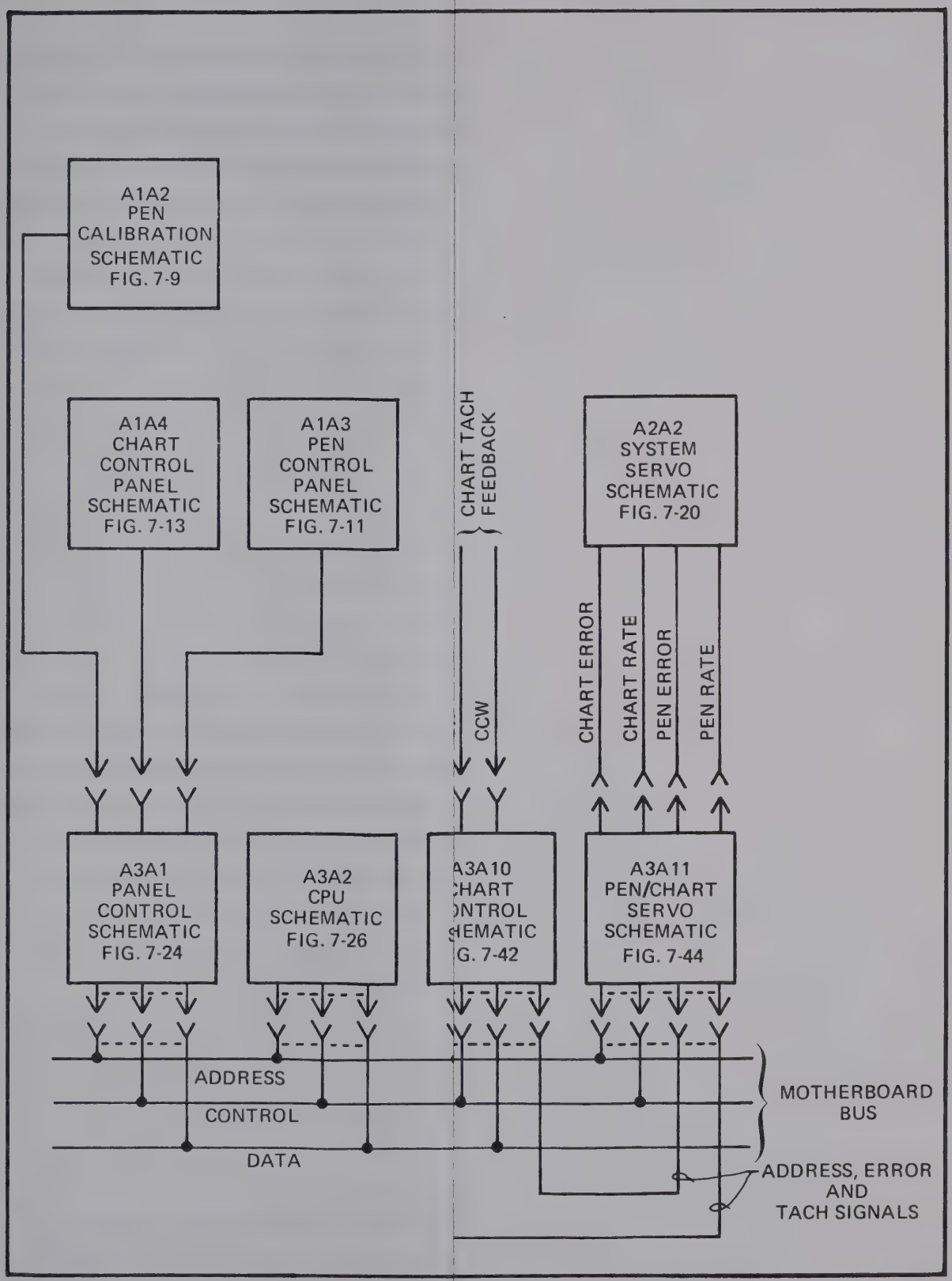


Figure 4-8. Detailed Block Diagram

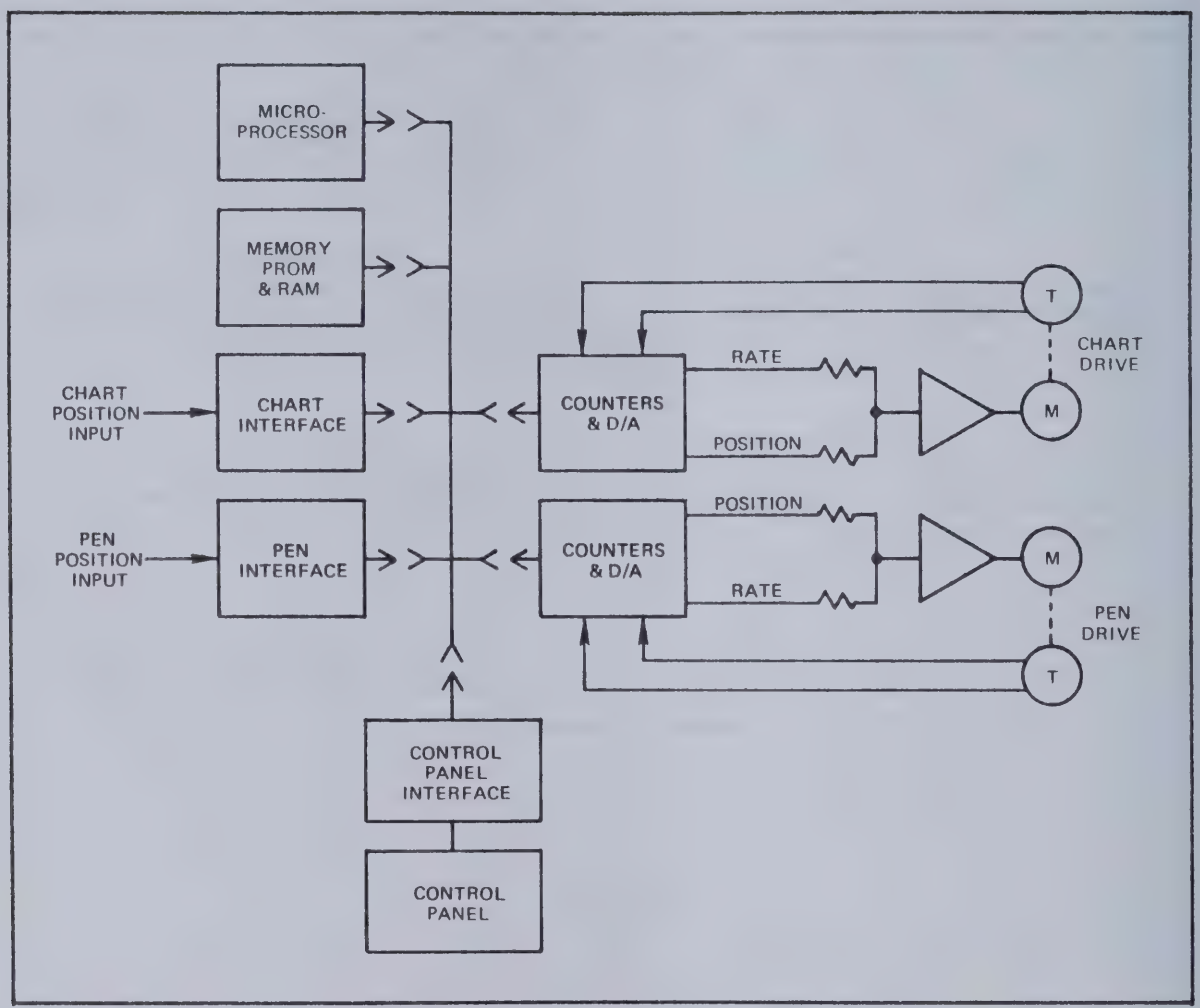


Figure 4-7. Digital Data Bus Routing, Simplified Block Diagram

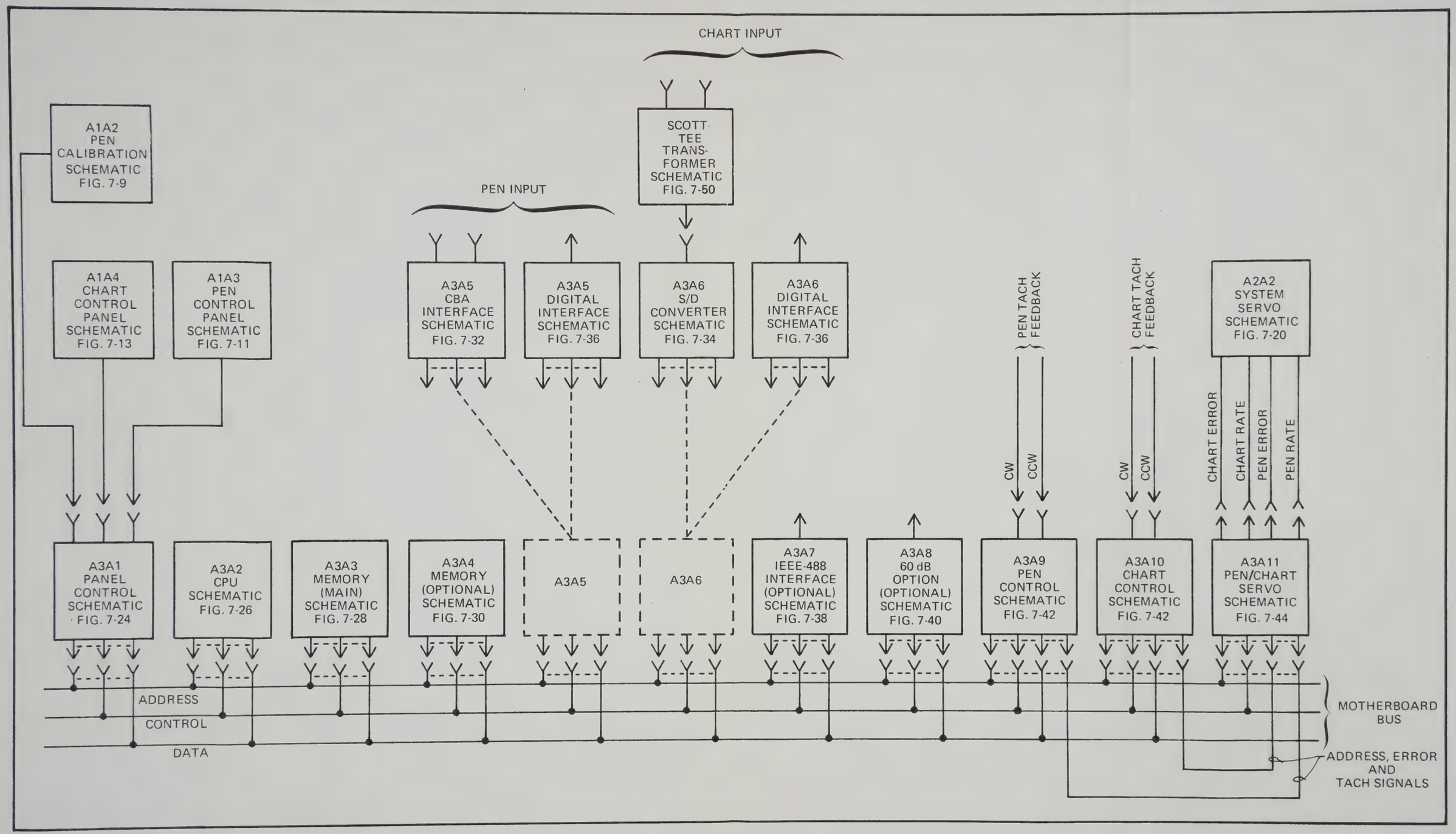


Figure 4-8. Detailed Block Diagram

4.3.6 Chart position input signals are applied through appropriate interface printed circuit boards which in turn connect to the microprocessor. The chart position input signals may be either BCD format or analog synchro data. Either input can be converted to proper digital format for transmission to the microprocessor by the proper interface printed circuit board. The chart position information, once inside the microprocessor and memory system is appropriately "scaled" by mathematical equations and output to the chart function digital-to-analog (D/A) converter. This converted signal then causes the chart motor to drive in a desired direction. As the chart motor shaft rotates, a tachometer connected directly to the motor shaft generates either clockwise or counterclockwise pulses. These pulses are returned to the microprocessor as a feedback signal to provide a means of monitoring chart position and thereby allowing complete servo control.

4.3.7 In general, the microprocessor reads the chart input (which may be the synchro input from an antenna positioner, for instance), scales the chart input signal, and determines the desired recorder chart position. The microprocessor then outputs a drive voltage through the digital-to-analog (D/A) converter. The recorder chart position is then monitored continuously and the D/A output signal is modified (through the microprocessor action) as is necessary to maintain the chart position.

4.3.8 A similar input and control system exists for the Model 1581 Pattern Recorder pen system. Input signals for the pen command may be in either BCD or binary format from the A/D converter interface for a CBA or DCA unit.

4.3.9 The block diagram shown in Figure 4-7 shows the basic recorder with the introduction to operating with a "bus" system concept throughout the Model 1581 Pattern Recorder digital section. Note that each of the very general blocks shown in

Figure 4-6 are now shown in Figure 4-7 as printed circuit boards, or modules, installed and interconnected using a common bus. Note also that both the microprocessor and memory are shown as two circuit modules, and the addition of an "interface" printed circuit board for the operators control panel.

4.3.10 Finally, Figure 4-8 shows the most detailed block diagram of the overall Model 1581 Pattern Recorder. General interconnections are shown for all the standard modules used in the Model 1581 Pattern Recorder as well as the optional modules. A summary of noteable differences supported by Figure 4-8 are listed as follows:

- The bus interconnections on and through the motherboard include the address, control and data lines which permit the microprocessor to communicate with the memory and all other modules connected into the bus.

- Either of two modules can interface through the A3A5 position to provide a proper input to the Model 1581 Pattern Recorder. These two modules are identified as the CBA/DCA Interface printed circuit board and the Digital Interface printed circuit board.

- Either of two modules can interface through the A3A6 position to provide a proper input to the Model 1581 Pattern Recorder. These two modules are identified as the Synchro-to-Digital (S/D) Interface printed circuit board and the Digital Interface printed circuit board.

- The microprocessor bus is connected through the Control Panel Interface printed circuit board (A3A1) to the Model 1581 Pattern Recorder control panels before interfacing with the recorder operation.

- Note that the IEEE-488 Interface printed circuit board (A3A7) is optional.

- Note that the 60 dB Option printed circuit board (A3A8) is also optional.

- Note that the Pen/Chart Servo Rate Loop printed circuit board (A3A1) does NOT connect to the microprocessor data bus but does connect to the address and control busses to perform normal operation.

- Note that the microprocessor memory capability can be expanded using the optional Memory printed circuit board (A3A4). The use of the expanded memory capability will be described in later paragraphs.

B. MAPPED MEMORY I/O

4.3.11 The microprocessor addresses each of the block diagram modules (or printed circuit boards) using the mapped memory I/O method. Basically, this is accomplished by defining a block of addresses which are stored outside of the system PROM or RAM address blocks.

4.3.12 Each module to be addressed by the microprocessor (such as a D/A storage register) is assigned a unique address within the block of addresses designated for the mapped I/O. An address decoder is wired to detect the assigned address and generate an output signal which is AND gated with an appropriate Write Enable or Read Enable from the microprocessor control bus. Each module is addressed as if it were a separate memory cell.

C. FIRMWARE DESCRIPTION

4.3.13 The program which operates the Model 1581 Pattern Recorder is contained in 4K of 16-bit words of Read Only Memory (ROM) on the Main Memory printed circuit board (A3A3). This function is separate from the 512 16-bit words of Read and Write (RAM) memory which is also part of the Main Memory printed circuit board. The RAM memory is used for computer registers, for storing program variables, and for buffering certain data. This buffering requirement will be explained in later paragraphs.

4.3.14 The Optional Memory printed circuit board (A3A4) contains 2K 16-bit words of ROM and 256 16-bit words of RAM. This Optional Memory printed circuit board is normally used to store Polar Option Programs and/or programs which are necessary for the operation of the IEEE-488 Option printed circuit board (A3A7).

4.3.15 Initial application of ac power to the Model 1581 Polar Recorder causes an interrupt signal to be generated which starts the main memory program to begin execution. The initial power-up sequence causes the error voltages to both chart and pen drive systems to be set at zero. Once control of the recorder system has been established by the microprocessor, a pen initialization procedure is started. This is necessary to establish a reference point for the microprocessor to use in tracking the pen position. Generally, the pen initialization procedure is to drive the pen against the right hand stop and then move away by a specified amount. This point is then the established reference point and should correspond to the top-most printed line on the chart paper.

4.3.16 Once the pen initialization procedure is complete, the normal recording action can begin. Refer to Figure 4-9 for a simplified diagram of the main memory program which shows the remaining operations are performed through the continuous execution of a program loop.

4.3.17 At the beginning of the program loop, the operation control panel switch positions are examined. The switch positions are decoded, sorted, and stored in RAM memory locations that can be examined or tested by all other recorder program. Also included are the option selections which allow certain auxiliary program functions, such as POLAR Plotting. The Pen Control printed circuit board (A3A9) is read under firmware control. Depending upon the information stored in RAM, firmware control reads the CBA/DCA Interface printed circuit board (A3A5) as a digital interface for the pen control input function.

4.3.18 Next, the firmware control similarly reads the Chart Interface functions and compares for flags in the RAM that would indicate if the Synchro-to-Digital (S/D) module option is supplying the chart input or if a chart Digital Interface option is installed.

4.3.19 Pen function calculations are dependant on the front panel switch selections and on the type of data being provided as pen function input through the Pen Control Interface circuits. The pen data may be binary (through the CBA/DCA Interface printed circuit board (A3A5) or BCD data (supplied by a Scientific-Atlanta Series 1830 Ratiometer or a Digital Phase Display through the Digital Interface printed circuit board (A3A5)). The pen function input signal may also be proportional to either amplitude or phase. Selection of the appropriate calculations to convert the pen data input is made and a pen servo position signal is generated. The pen position is also stored for later use.

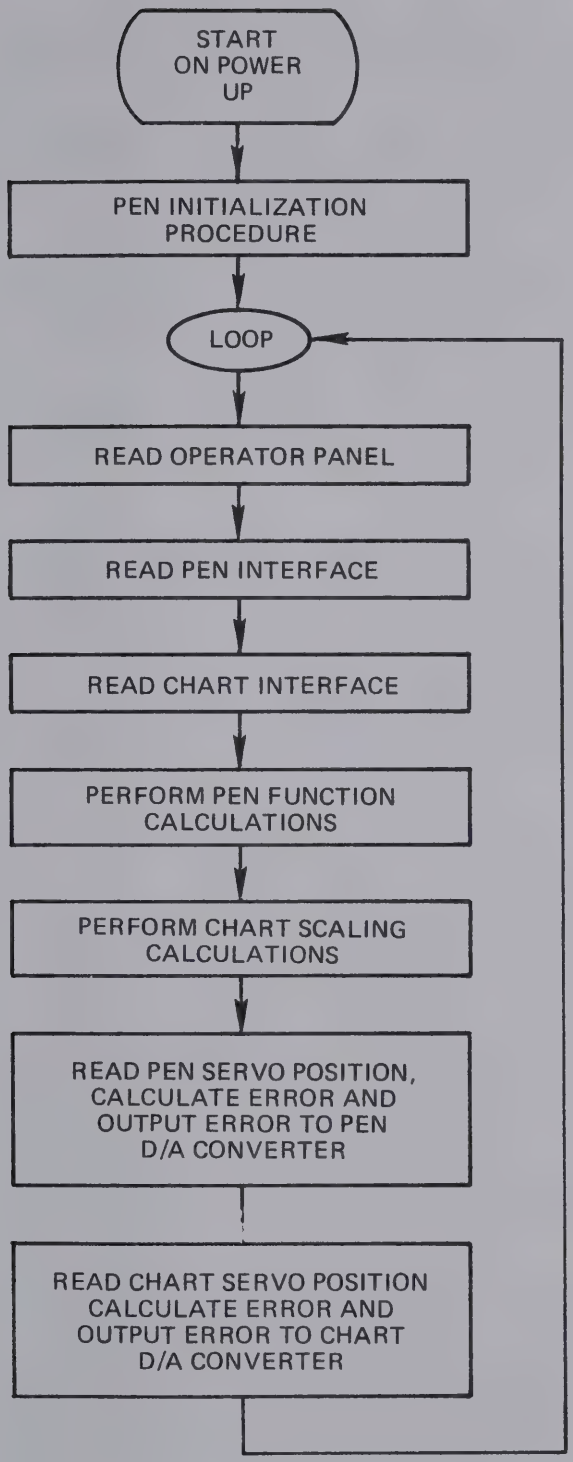


Figure 4-9. Main Memory Program Flowchart

4.3.20 Similarly, the chart scaling input signal is based on control panel switch selections and stored in RAM. The chart data as obtained from the chart interface functions is converted to chart servo position signals for command and for storage.

4.3.21 The next program task is to read the actual pen position as determined by hardware counters and calculate an error voltage based on the pen position information supplied by the pen function program. It is the calculated error voltage that is output to the pen servo Digital-to-Analog converters.

4.3.22 After the pen position task is analyzed, the chart position is similarly determined. The chart position is read from hardware counters to determine and generate an error voltage based on chart position information. The error voltage is output to the chart servo Digital-to-Analog converters.

4.3.23 The block diagram in Figure 4-9 does not show extra functions such as Chart Space, Chart Run, Pen Lift, and others. Functions such as Chart Space and Chart Cycle are available through program control. For each Chart Space or Chart Cycle command received from the front panel controls, additional chart errors are carefully added to produce chart motion for the correct repositioning of the chart paper. These errors are determined by a "chart skip' routine and are added to the chart error by the chart error program.

4.3.24 The Chart Run function is performed in a similar sequence of steps except the error is added continuously until the operator releases the front panel (chart run) switch.

D.SOFTWARE DESCRIPTION

4.3.25 Programs which provide normal operation for the Series 1580 Pattern Recorder are stored in the Main Memory printed circuit board (A3A3) and occupy approximately 4000 16-bit words. The Main Memory printed circuit board also provides 512 16-bit words of read and write Random Access Memory (RAM). The RAM memory is used for (1) the computer register; for (2) storing program variables; and (3) for buffering certain data.

4.3.26 The Optional Memory printed circuit board (A3A4) contains 2000 16-bit words of Read Only Memory (ROM) and 512 16-bit words of RAM. The Optional Memory printed circuit board stores both the Polar Option programs and the programs necessary to operate with the IEEE-488 Interface option printed circuit board (A3A7).

4.3.27 Upon application of ac power to the Series 1580 Pattern Recorder, an interrupt signal is generated which causes the Main Memory program to begin execution. The initial power-up sequence causes error voltages to both the pen and chart drive systems to be set to zero. Once control of the recorder system has been established by the microprocessor, a pen initialization procedure begins. This is necessary to establish a reference point for the microprocessor to use in tracking the pen position. Generally, the pen initialization procedure is to drive the pen against the right-hand stop and then move away by a specified amount and establish this point as the reference. This reference point should also correspond to the top-most printed line on the chart paper. Once pen initialization is complete, normal recorder action begins.

4.4 CENTRAL PROCESSOR UNIT (CPU) PRINTED CIRCUIT BOARD ASSEMBLY (A3A2)

4.4.1 The Central Processor Unit (hereafter referred to as CPU) printed circuit board (A3A2) provides normal operation through the functions of a Texas Instrument TMS 9900 microprocessor chip (see Figure 4-10) circuit to control the Series 1580 Pattern Recorder. The TMS 9900 is a single chip 16-bit CPU operating with a 16-bit wide Data bus and a 15-bit wide Address bus. Control signals are provided for Memory Enable, Write Enable, and Data bus control. The functions of Interrupt Request and Interrupt Identification are also provided.

4.4.2 A simplified block diagram of the CPU printed circuit board functions is shown in Figure 4-11. Required clock signals for the microprocessor are supplied by the Four Phase Clock Generator and Drive circuit provided through the operation of IC U1. Frequency control is provided by a 48 MHz, third overtone crystal (shown in the schematic, Figure 7-26, as component Y1) and the tank circuit of inductor L1 and capacitor C2. Dividers internal to U1 are responsible for providing a 3.0 MHz 4-phase clock output through IC U1, pins 12, 11, 8, and 9. Other pins and their designated functions are described in Table 4-1.

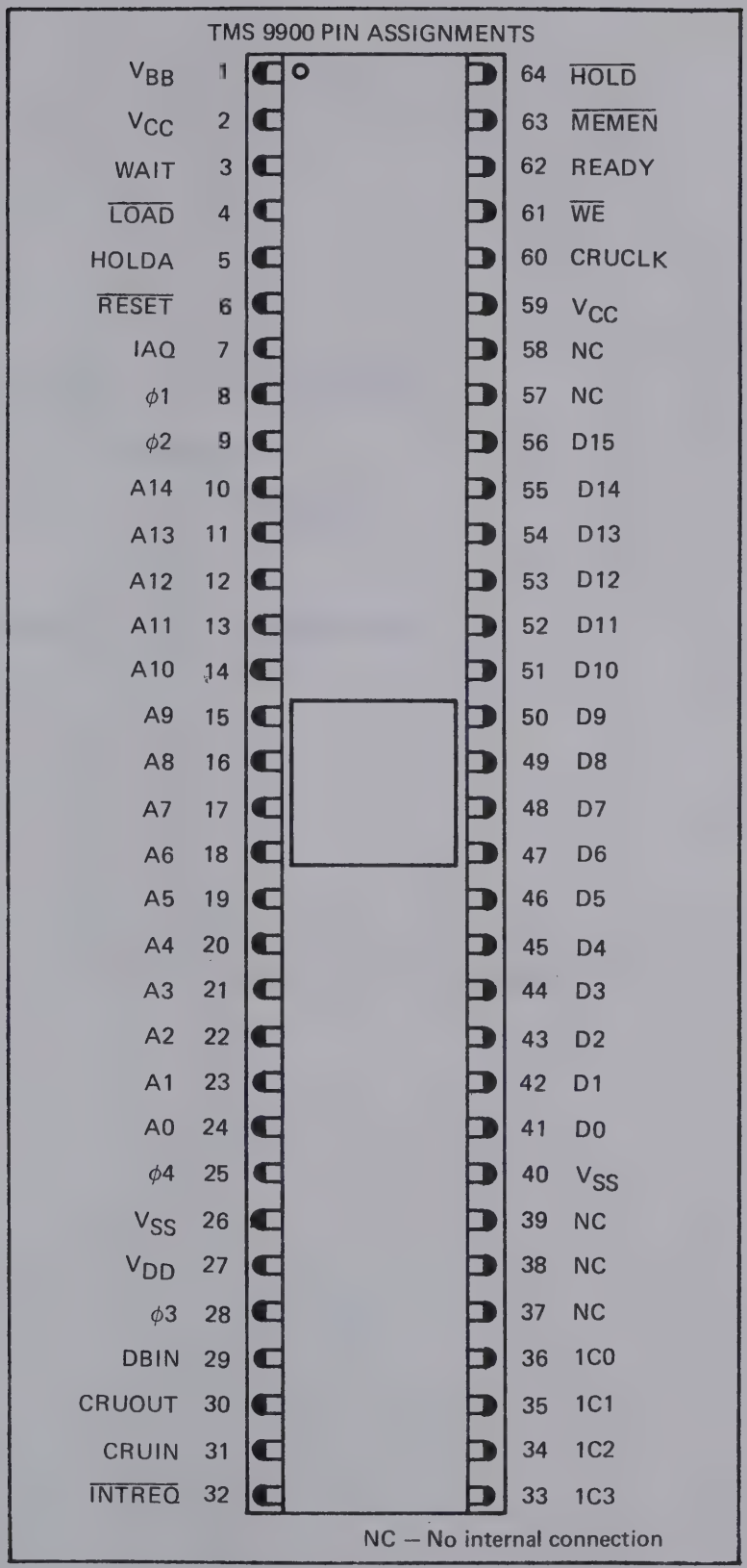


Figure 4-10. Outline and Pin Functions of Control Processor Unit (CPU) Printed Circuit Board Assembly (A3A2) Microprocessor

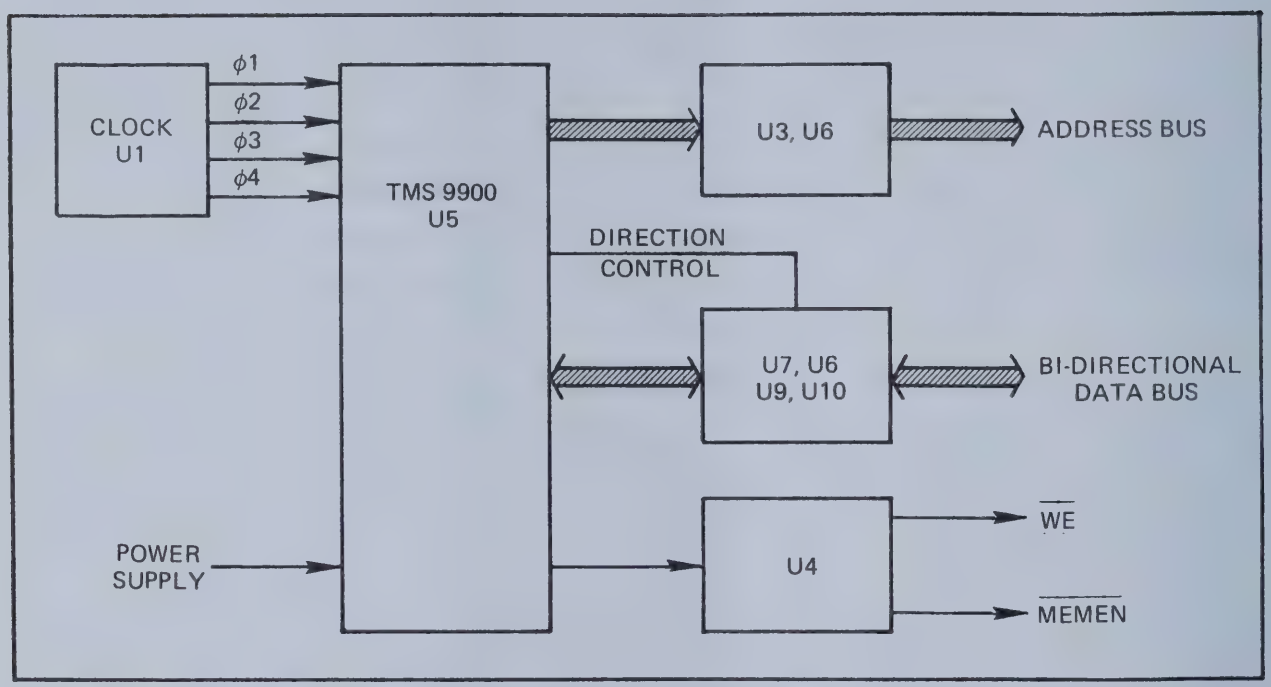


Figure 4-11. Control Processor Unit (CPU) Printed Circuit Board Assembly (A3A2) Simplified Block Diagram

Table 4-1
CPU TMS 9900 Pin Assignments and Functions

Signature	Pin	I/O	Description
			ADDRESS BUS
A0 (MSB)	24	OUT	A0 through A14 comprise the address bus. This 3-state bus provides the memory address vector to the external-memory system when $\overline{\text{MEMEN}}$ is active and I/O-bit addresses and external-instruction addresses to the I/O system when $\overline{\text{MEMEN}}$ is inactive. The address bus assumes the high-impedance state when HOLDA is active.
A1	23	OUT	
A2	22	OUT	
A3	21	OUT	
A4	20	OUT	
A5	19	OUT	
A6	18	OUT	
A7	17	OUT	
A8	16	OUT	
A9	15	OUT	
A10	14	OUT	
A11	13	OUT	
A12	12	OUT	
A13	11	OUT	
A14 (LSB)	10	OUT	
			DATA BUS
D0 (MSB)	41	I/O	D0 through D15 comprise the bi-directional 3-state data bus. This bus transfers memory data to (when writing) and from (when reading) the external-memory system when $\overline{\text{MEMEN}}$ is active. The data bus assumes the high-impedance state when HOLDA is active.
D1	42	I/O	
D2	43	I/O	
D3	44	I/O	
D4	45	I/O	
D5	46	I/O	
D6	47	I/O	
D7	48	I/O	
D8	49	I/O	
D9	50	I/O	
D10	51	I/O	
D11	52	I/O	

Table 4-1 continued

Signature	Pin	I/O	Description
			DATA BUS (continued)
D12	53	I/O	
D13	54	I/O	
D14	55	I/O	
D15 (LSB)	56	I/O	
			POWER SUPPLIES
V_{BB}	1		Supply voltage (-5V NOM)
V_{CC}	2,59		Supply voltage (5V NOM). Pins 2 and 59 must be connected in parallel.
V_{DD}	27		Supply voltage (12V NOM)
V_{SS}	26,40		Ground references. Pins 26 and 40 must be connected in parallel.
			CLOCKS
$\phi 1$	8	IN	Phase-1 clock
$\phi 2$	9	IN	Phase-2 clock
$\phi 3$	28	IN	Phase-3 clock
$\phi 4$	25	IN	Phase-4 clock
			BUS CONTROL
DBIN	29	OUT	Data bus in. When active (high), DBIN indicates that the TMS 9900 has disabled its output buffers to allow the memory to place memory-read data on the data bus during $\overline{\text{MEMEN}}$. DBIN remains low in all other cases except when HOLDA is active.

Table 4-1 continued

Signature	Pin	I/O	Description
			BUS CONTROL (continued)
$\overline{\text{MEMEN}}$	63	OUT	Memory enable. When active (low), $\overline{\text{MEMEN}}$ indicates that the address bus contains a memory address.
$\overline{\text{WE}}$	61	OUT	Write enable. When active (low), $\overline{\text{WE}}$ indicates that memory write data is available from the TMS 9900 to be written into memory.
CRUCLK	60	OUT	CRU clock. When active (high), CRUCLK indicates that external interface logic should sample the output data on CRUOUT or should decode external instructions on A0 through A2.
CRUIN	31	IN	CRU data in. CRUIN, normally driven by 3-state or open-collector devices, receives input data from external interface logic. When the processor executes a STCR or TB instruction, it samples CRUIN for the level of the CRU input bit specified by the address bus (A3 through A14).
CRUOUT	30	OUT	CRU data out. Serial I/O data appears on the CRUOUT line when an LDCR, SBZ, or SBO instruction is executed. The data on CRUOUT should be sampled by external I/O interface logic when CRUCLK goes active (high).

Table 4-1 continued

Signature	Pin	I/O	Description
			INTERRUPT CONTROL
$\overline{\text{INTREQ}}$	32	IN	Interrupt request. When active (low), $\overline{\text{INTREQ}}$ indicates that an external interrupt is requested. If $\overline{\text{INTREQ}}$ is active, the processor loads the data on the interrupt-code-input lines IC0 through IC3 into the interrupt-code-storage register. The code is compared to the interrupt mask bits of the status register. If equal or higher priority than the enabled interrupt level (interrupt code equal or less than status register bits 12 through 15) the TMS 9900 interrupt sequence is initiated. If the comparison fails, the processor ignores the request. $\overline{\text{INTREQ}}$ should remain active and the processor will continue to sample IC0 through IC3 until the program enables a sufficiently low priority to accept the request interrupt.
IC0 (MSB)	36	IN	Interrupt codes. IC0 is the MSB of interrupt code, which is sampled when $\overline{\text{INTREQ}}$ is active. When IC0 through IC3 ar LLLH, the highest external-priority interrupt is being requested and when HHHH, the lowest-priority interrupt is being requested.
IC1	35	IN	
IC2	34	IN	
IC3 (LSB)	33	IN	

Table 4-1 continued

Signature	Pin	I/O	Description
			MEMORY CONTROL
$\overline{\text{HOLD}}$	64	IN	Hold. When active (low), $\overline{\text{HOLD}}$ indicates to the processor that an external controller (e.g., DMA device) desires to utilize the address and data buses to transfer data to or from memory. The TMS 9900 enters the hold state following a hold signal when it has completed its present memory cycle.* The processor then places the address and data buses in the high-impedance state (along with $\overline{\text{WE}}$, $\overline{\text{MEMEN}}$, and DBIN) and responds with a hold-acknowledge signal (HOLDA). When $\overline{\text{HOLD}}$ is removed, the processor returns to normal operation.
			*If the cycle following the present memory cycle is also a memory cycle, it, too, is completed before the TMS 9900 enters the hold state. The maximum number of consecutive memory cycles is three.
HOLDA	5	OUT	Hold acknowledge. When active (high), HOLDA indicates that the processor is in the hold state and the address and data buses and memory control outputs ($\overline{\text{WE}}$, $\overline{\text{MEMEN}}$, and DBIN) are in the high-impedance state.

Table 4-1 continued

Signature	Pin	I/O	Description
			MEMORY CONTROL (continued)
READY	62	IN	Ready. When active (high), READY indicates that memory will be ready to read or write during the next clock cycle. When not-ready is indicated during a memory operation, the TMS 9900 enters a wait state and suspends internal operation until the memory systems indicate ready.
WAIT	3	OUT	Wait. When active (high), WAIT indicates that the TMS 9900 has entered a wait state because of a not-ready condition from memory.
			TIMING AND CONTROL
IAQ	7	OUT	Instruction acquisition. IAQ is active (high) during any memory cycle when the TMS 9900 is acquiring an instruction. IAQ can be used to detect illegal op codes.
$\overline{\text{LOAD}}$	4	IN	Load. When active (low), $\overline{\text{LOAD}}$ causes the TMS 9900 to execute a nonmaskable interrupt with memory address FFFC_{16} containing the trap vector (WP and PC). The load sequence begins after the instruction being executed is completed. $\overline{\text{LOAD}}$ will also terminate an idle state. If $\overline{\text{LOAD}}$ is active during the time $\overline{\text{RESET}}$ is released, then the $\overline{\text{LOAD}}$

Table 4-1 continued

Signature	Pin	I/O	Description
			TIMING AND CONTROL (continued)
			trap will occur after the $\overline{\text{RESET}}$ function is completed. $\overline{\text{LOAD}}$ should remain active for one instruction period. IAQ can be used to determine instruction boundaries. This signal can be used to implement cold-start ROM loaders. Additionally, front-panel routines can be implemented using CRU bits as front-panel-interface signals and software control routines to control the panel operations.
$\overline{\text{RESET}}$	6	IN	Reset. When active (low), $\overline{\text{RESET}}$ causes the processor to be reset and inhibits $\overline{\text{WE}}$ and CRUCLK. When $\overline{\text{RESET}}$ is released, the TMS 9900 then initiates a level-zero interrupt sequence that acquires WP and PC from locations 0000 and 0002, sets all status register bits to zero, and starts execution. $\overline{\text{RESET}}$ will also terminate an idle state. $\overline{\text{RESET}}$ must be held active for a minimum of three clock cycles.

4.4.3 To provide a $\overline{\text{RESET}}$ signal at Power Up, an R/C (resistor R8 and capacitor C4) reset delay circuit slows the rise of +5.0 volts to the Schmidt Trigger input of U1 until all power supply voltages are present. The $\overline{\text{RESET}}$ signal is then sent to the Phase-3 Clock ($\phi 3$) input of the TMS 9900 to indicate program execution.

4.4.4 The Address Bus from the TMS 9900 is buffered through the operation of Eight-Bit Input/Output Ports provided by circuits using U3 and U6. A Quadruple Bus Tranceiver, arranged through the circuits using U7, U8, U9, and U10, buffer the TMS 9900 Data Bus. These devices are bidirectional drivers and buffer the Data Bus into and out of the TMS 9900. The signal direction is controlled by the Data Bus In (DBIN) function.

4.4.5 The signal designated $\overline{\text{SLOMEM}}$ (see Figure 7-26) provides a means for an external device to cause one additional microprocessor WAIT state during memory access. The Eight-Bit Input/Output Port (U4) is also used to buffer control signals from the TMS 9900. Functions designated Write Enable Not ($\overline{\text{WE}}$) and Memory Enable Not ($\overline{\text{MEMEN}}$) are used throughout the Model 1581 Pattern Recorder. The CRU functions (i.e., CRUCLK, CRUOUT, and CRUIN) are the serial communications I/O for the TMS 9900 and are not used in the Model 1581 Pattern Recorder operation.

4.5 MAIN MEMORY PRINTED CIRCUIT BOARD ASSEMBLY (A3A3) AND OPTIONAL MEMORY PRINTED CIRCUIT BOARD ASSEMBLY (A3A4)

4.5.1 The Model 1581 Pattern Recorder is provided with connections for two memory storage printed circuit boards. The Main Memory printed circuit board (A3A3) is required for normal operation and the use of the Optional Memory printed circuit board (A3A4) provides extended recording features and capabil-

ity. The two Memory printed circuit boards are identical with exception to the contents of the ROM (Read Only Memory) circuits and the Address jumper selections.

4.5.2 Main Memory (A3A3) printed circuit board ROM's contain the basic control, scaling, and function programs for the Model 1581 Polar Recorder operation. The Optional Memory (A3A4) printed circuit board ROM's contain the programming necessary for Polar Plotting and for operation with the IEEE-488 Interface option. The Optional Memory printed circuit board is not required for basic operation of the Model 1581 Pattern Recorder.

4.5.3 All ROM circuits use the Texas Instrument TI 2716 EPROM (Eraseable Programmable Read Only Memory) IC chips. Each EPROM contains 2048 8-bit bytes. When used with the TMS 9900 CPU which operates from a 16-bit Data Bus, the Memory printed circuit boards use two EPROM circuits in parallel.

4.5.4 Figure 4-12 is a simplified block diagram of a Memory printed circuit board. As noted in the previous paragraph, ROM circuits U7 and U6 are each 8-bits wide by 2048 deep, and paralleled together, the two circuits form a memory block of 2048 16-bit words. Normal main memory of the Model 1581 Pattern Recorder uses two pair of ROM circuits (U7, U6 and U8, U5, in Figure 4-12) providing a total of 4096 16-bit words of Read Only Memory.

4.5.5 The Random Access Memory (RAM) circuits (U13, U4, U10, and U11 in Figure 4-12) are each 4-bit wide by 256 deep. They are also parallel connected to provide a memory block of 256 16-bit words. Similarly, RAM circuits U12, U3, U11, and U12 provide a second block of 256 16-bit words to supplement the Read and Write Memory functions of a Model 1581 Pattern Recorder.

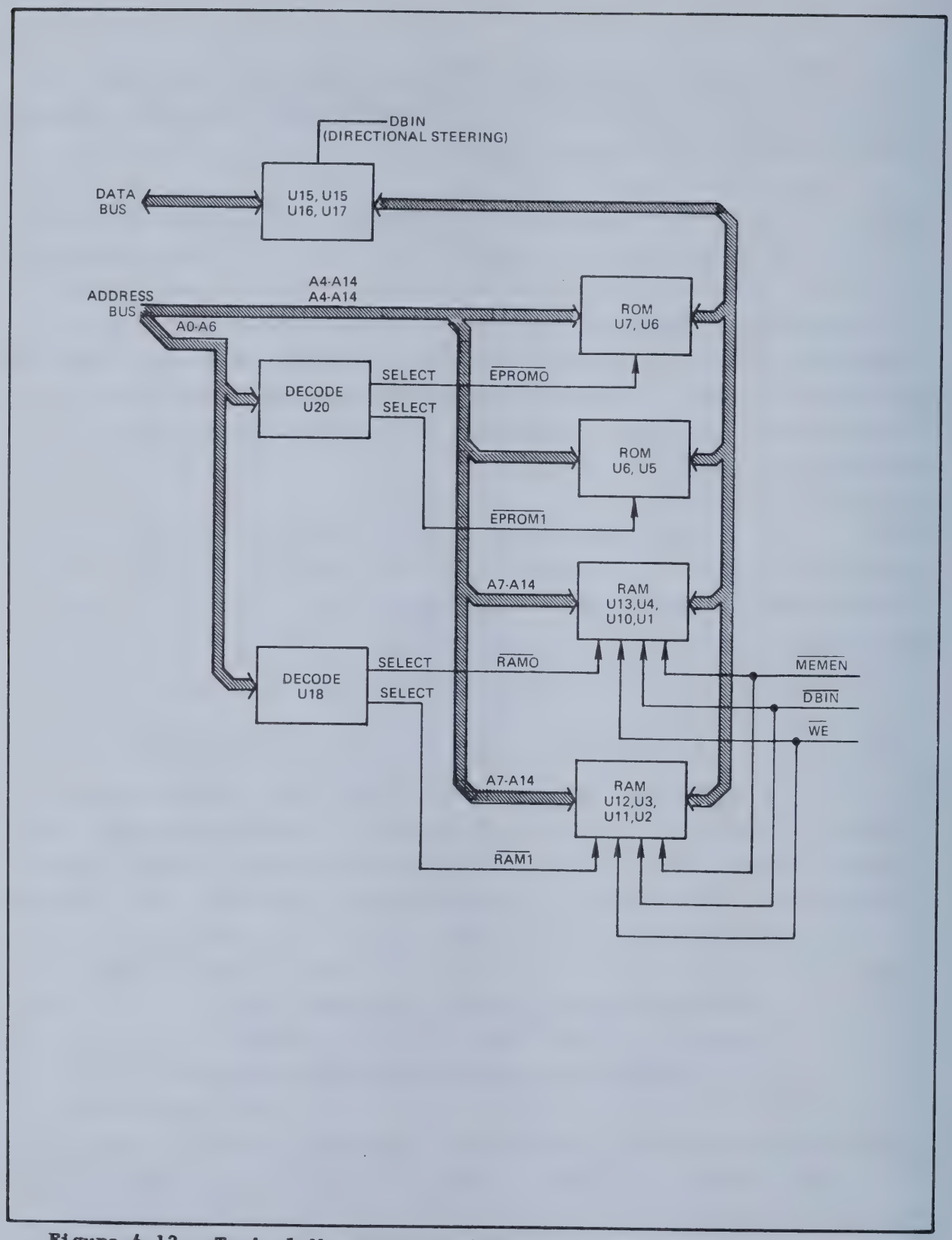


Figure 4-12. Typical Memory Printed Circuit Board Assembly (A3A3 and/or A3A4), Simplified Block Diagram

4.5.6 Each ROM or RAM memory element is connected to the 16-bit Data Bus and to a portion of the Address Bus. Either a ROM or RAM "group" is selected for Data Bus input/output through decoding circuits provided by U18 and U20 which examine the most significant bits of the address field. As an example, pressume a ROM (such as U7, U6) is being addressed. The address field A4 through A14 define a particular word of ROM, but selection occurs in both ROM (U7, U6) and ROM (U8, U5). By decoding the address field A0 through A4 using U20 circuits, a unique select signal ($\overline{\text{EPROM0}}$) is generated for the ROM (U7, U6). This example illustrates how only the selected ROM will place its data on the 16-bit Data Bus.

4.5.7 RAM addressing is similar to the ROM operation, but an additional group of signals (i.e., $\overline{\text{MEMEN}}$, $\overline{\text{DBIN}}$, $\overline{\text{WE}}$) are required to qualify the appropriate RAM for access to the Data Bus.

4.5.8 Data Bus direction steering (for read or write functions) is performed by circuits U14, U15 and U16, U17 arranged as bidirectional bus drivers. Both Memory printed circuit boards are provided with a number of selectable options and addresses. These are listed in the following tables for reference.

Table 4-2
ROM (EPROM) Device Selection

TI 2708 EPROM (8-bits x 1024)	TI 2716 EPROM (8-bits x 2048)
E1 to E2	E1 Not Connected
E3 to E4	E2 to E3
E5 to E6	E4 to E5
E7 to E8	E6 to E7
E9 Not Connected	E8 to E9

NOTE: Both the Main Memory and Optional Memory printed circuit boards require the TI 2716 EPROM format for operation with the Model 1581 Pattern Recorder.

Table 4-3
ROM (EPROM) Address Select

Terminal	TI 2708 EPROM	TI 2716 EPROM
E10	0000 to 07FE	0000 to 0FFE
E11	0800 to 0FFE	1000 to 1FFE
E12	1000 to 17FE	2000 to 2FFE
E13	1800 to 1FFE	3000 to 3FFE
E14	2000 to 27FE	(Not Applicable)
E15	2800 to 2FFE	(Not Applicable)
E16	3000 to 37FE	(Not Applicable)
E17	3800 to 3FFE	(Not Applicable)

Connections for Main Memory printed circuit board:

E18 to E10 for Address 0000 to 0FFE
E19 to E11 for Address 1000 to 1FFE

Connections for Optional Memory printed circuit board:

E18 to E12 for Address 2000 to 2FFE
E19 is not used

Table 4-4
RAM Address Select

Terminal	Address
E20	C000 to C1FE
E21	C200 to C3FE
E22	C400 to C7FE
E23	C800 to C9FE
E24	CA00 to CBFE
E25	CC00 to CDFE
E26	CE00 to CFFE

Connections for Main Memory printed circuit board:

E28 to E20 for Address C000 to C1FE
E29 to E21 for Address C200 to C3FE

Connections for Optional Memory printed circuit board:

E28 to E22 for Address C400 to C7FE
E29 to E23 for Address C800 to C9FE

4.6 CONTROL PANEL INTERFACE PRINTED CIRCUIT BOARD ASSEMBLY (A3A1)

4.6.1 A block diagram of the Control Panel Interface printed circuit board (A3A1) functions is shown in Figure 4-13. The Control Panel Interface printed circuit board connects the Chart Control Panel (A1A2), the Pen Control Panel (A1A3), and the Pen Calibrate Assembly (A1A3) to the microprocessor (data) bus. Normally, the Control Panel Interface circuits permit the addressable data gates to examine the status of all front panel switches under control of the microprocessor firmware instructions. There is also an addressable storage register which permits both the operation of front panel indicators and the operation of the pen lift solenoid through the microprocessor firmware instructions.

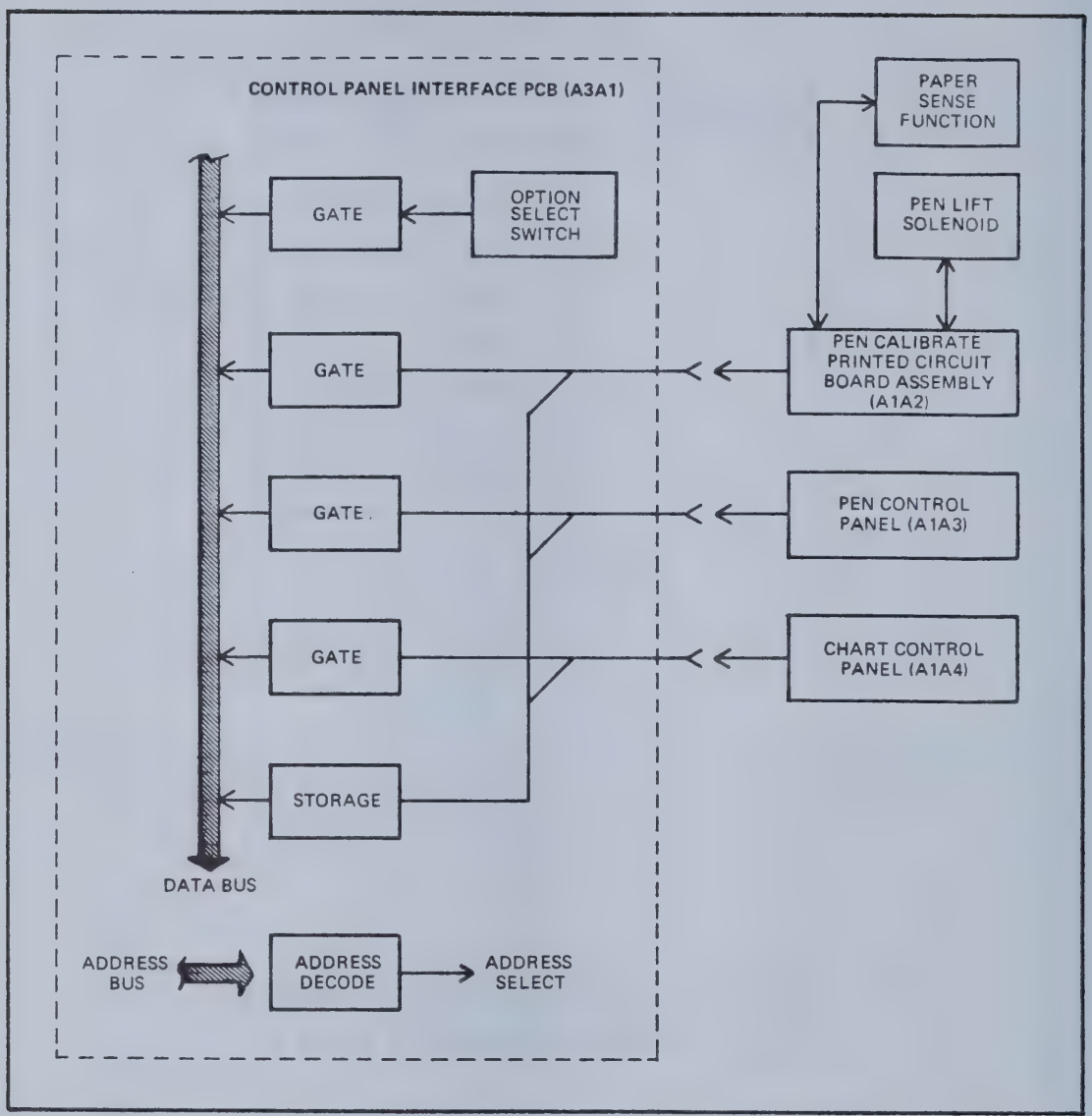


Figure 4-13. Control Panel Interface Printed Circuit Board Assembly (A3A1), Simplified Block Diagram

4.6.2 The Chart Control Panel (A1A4) functions are interconnected to the Control Panel Interface printed circuit board through connectors J1 and J2. The Pen Control Panel (A1A3) is similarly interfaced through connector J3 and Pen Calibrate Assembly (A1A3) through connector J4. Both the Chart Control Panel and Pen Control Panel permit certain operator selections by momentarily pressing switches, such as PEN FUNCTION Select, the Pen Scale Select, the CHART DEGREES (Scale) Select, CHART CYCLE, and others. To avoid problems related with contact bounce and to insure the command is saved until read by the firmware command, the momentary contact closures are latched by the operation of IC's U3 and U4.

4.6.3 Latched data being stored in the U3 and U4 circuits is reset by firmware control after the latches are read by addressing the IC U13. Operation of gate U11 permits the latch contents to be gated onto the microprocessor data bus. Other control panel switches and control lines are read directly onto the bus through operation of gates U10 and U1.

4.6.4 Data being stored by firmware instructions in the circuits of U9 and U12 operate the control panel indicators and the pen lift solenoid. Only two front panel indicators are illuminated at a given time through the operation of U12. There can be only one Pen Function indicator and one Chart Function indicator illuminated during normal operation. Each front panel indicator is a light emitting diode (LED) and current limiting for all indicators is provided through resistors R1 through R5, inclusive. The Pen Scale and Remote indicators are driven by the circuits of U9, but the Pen Lift (PLIFT) command used in this circuit arrangement is first buffered by drive transistors on the Pen Calibrate Assembly (A1A2). Pull-up resistors required for this circuit arrangement are contained in DIP assemblies identified as U2, U5, and U6.

4.6.5 Recorder options are selected by proper positioning of the eight rocker-type switches provided in the DIP package shown as U16. These switches permit the microprocessor firmware to determine which options the Model 1581 Recorder will respond to. The switch selections are listed as follows:

Switch Position	Option Selection
1	Polar Option
2	Spare (must be positioned OFF)
3	CBA Option, Pen input
4	Digital Option, Pen input
5	Digital Option, Chart input
6	Synchro Converter Option, Chart input
7	60 dB Option
8	IEEE 488 Interface Option

4.6.6 Selection of an option requires the appropriate switch(es) to be operated into the ON position while the remaining switches are in the OFF position. Normal operation of a selected option also requires the installation of all correct hardware into the Model 1581 Recorder.

A.PEN CONTROL PANEL (A1A3)

4.6.7 The Pen Control Panel (A1A3) provides the switches and indicators which are solely related to the operation of the Model 1581 Recorder pen. Switch positions are monitored and panel indicators are illuminated through the circuits provided by the Control Panel Interface printed circuit board (A3A1). All pen operations resulting from the various switch position controls are performed by the microprocessor firmware instructions. This panel also provides the ac POWER-ON control switch.

B. PEN CALIBRATE ASSEMBLY (A1A2)

4.6.8 The Pen Calibrate Assembly (A1A2) performs two functions: (1) Permits operator selection of the Pen Calibrate function; and (2) Provides the proper interface to the pen lift solenoid and paper sensors.

4.6.9 Switch S3 permits the selection of the Pen Calibrate function. When switch S3 is positioned to ON, the pen is motor driven to the extreme left side of the chart paper. Then, by adjusting the digital switches S1 and S2, the pen point can be adjusted directly over the last printed line on the chart paper "bottom". This feature allows adjustment of the pen range to correct for chart paper instability due to humidity and temperature. The resulting digital values as represented by switches S1 and S2 are then used by the microprocessor as a calibration reference to correct for all pen position calculations.

4.6.10 The pen lift solenoid is operated through a solid state relay located in the Model 1581 Pattern Recorder Head Assembly (A1). The solid state relay is energized using a low voltage signal applied through resistor A1R1. Connections to the solid state relay are provided through terminals E9 and E10.

4.6.11 The Model 1581 Pattern Recorder provides two paper sensors which are interfaced through the Pen Calibrate Assembly (A1A2). A paper edge sensor interfaces through terminals E3, E4, E5, and E6. This sensor is a reflective infra-red device (with both transmitter and receiver) mounted on the Model 1581 Pattern Recorder Head Assembly (A1). As the paper edge moves up onto the recorder platen, this sensor is activated and the chart paper is run in a forward direction for one chart cycle. This sensor is used to prevent accidental winding up of chart paper onto the supply reel.

4.6.12 A second paper supply sensor is interfaced at terminals E1 and E2. This sensor is a microswitch with a "feeler arm" which monitors the paper supply roll diameter. It should be noted that operation of the Model 1581 Recorder is not stopped because of a low paper supply error.

C. CHART CONTROL PANEL (A1A4)

4.6.13 The Chart Control Panel (A1A4) provides the switches and indicators which are solely related to the operation of the Model 1581 Recorder chart. Switch positions are monitored and panel indicators are illuminated through the circuits provided by the Chart Panel Interface printed circuit board (A3A1). All chart operations resulting from the various switch position controls are performed by the microprocessor firmware instructions.

4.7 PEN CALIBRATE PRINTED CIRCUIT BOARD ASSEMBLY (A3A9) AND CHART CONTROL PRINTED CIRCUIT BOARD ASSEMBLY (A3A10)

4.7.1 Control of the Model 1581 Pattern Recorder Pen and Chart drive systems are performed by the microprocessor which monitors both motor shaft positions and provides the proper drive voltages as necessary to correct for a detected change in position. Figure 4-14 is a block diagram of the pen/chart control module. This module uses two identical and interchangeable printed circuit boards in locations A3A9 for the Pen Control function and A3A10 for the Chart Control function. Address decoding for both A3A9 and A3A10 is performed by the U9 circuits located on A3A11.

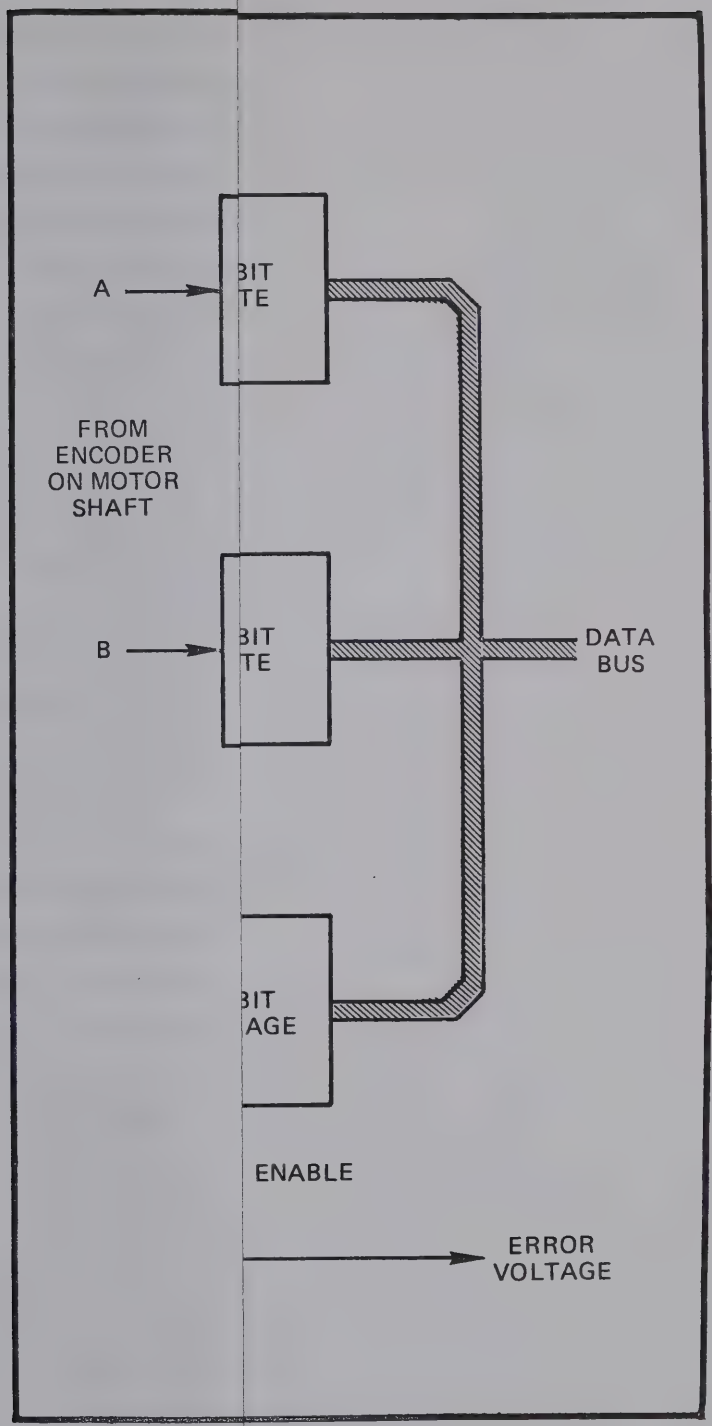


Figure 4-14. Pen Control PCB Assembly (A3A9) and/or Chart Control PCB Assembly (A3A10), Simplified Block Diagram

4.6.12 A second paper supply sensor is interfaced at terminals E1 and E2. This sensor is a microswitch with a "feeler arm" which monitors the paper supply roll diameter. It should be noted that operation of the Model 1581 Recorder is not stopped because of a low paper supply error.

C. CHART CONTROL PANEL (A1A4)

4.6.13 The Chart Control Panel (A1A4) provides the switches and indicators which are solely related to the operation of the Model 1581 Recorder chart. Switch positions are monitored and panel indicators are illuminated through the circuits provided by the Chart Panel Interface printed circuit board (A3A1). All chart operations resulting from the various switch position controls are performed by the microprocessor firmware instructions.

4.7 PEN CALIBRATE PRINTED CIRCUIT BOARD ASSEMBLY (A3A9) AND CHART CONTROL PRINTED CIRCUIT BOARD ASSEMBLY (A3A10)

4.7.1 Control of the Model 1581 Pattern Recorder Pen and Chart drive systems are performed by the microprocessor which monitors both motor shaft positions and provides the proper drive voltages as necessary to correct for a detected change in position. Figure 4-14 is a block diagram of the pen/chart control module. This module uses two identical and interchangeable printed circuit boards in locations A3A9 for the Pen Control function and A3A10 for the Chart Control function. Address decoding for both A3A9 and A3A10 is performed by the U9 circuits located on A3A11.

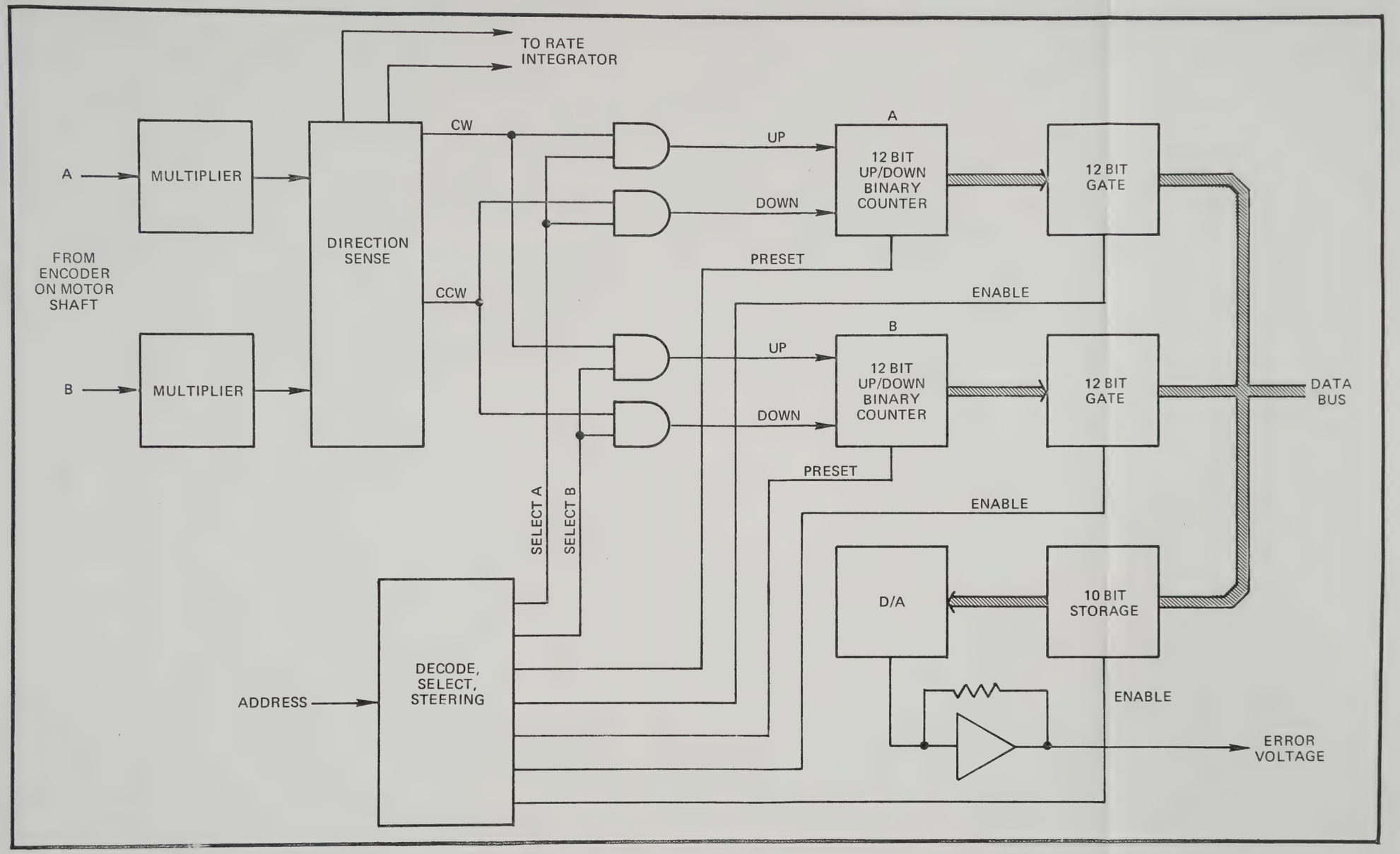


Figure 4-14. **Pen Control PCB Assembly (A3A9) and/or Chart Control PCB Assembly (A3A10), Simplified Block Diagram**

4.7.2 Control of the pen and chart drive system is performed by the microprocessor through monitoring the respective motor shaft position and providing a drive voltage to the motor to correct for detected changes in position. Monitoring is provided from a motor shaft encoder which generates a series of pulses representing the clockwise or counterclockwise motor-rotation. The pulses are accumulated in respective up/down counter circuits. At the proper time, contents of a counter is read into the microprocessor to determine any change in the motor position relative to the previous time period and read out. A change in motor position causes a digital error word to be generated which is put into a storage register to be an input for the digital-to-analog (D/A) converter.

4.7.3 The following description is referenced to the block diagram shown in Figure 4-14 and the schematic drawing shown in Figure 7-42.

4.7.4 A motor encoder is attached to the shaft of the pen motor and a similar unit is attached to the chart motor. The main difference between encoders is that the pen encoder is designed to produce approximately 1200 pulses per revolution and the chart encoder is designed to produce approximately 500 pulses per revolution. As a motor shaft rotates, the attached encoder generates two square waves which are (ideally) in quadrature (90^{o} apart). The relative phase of these two waveforms reverse when the motor shaft rotation changes directions. The phase of the encoder waveforms are constantly monitored to determine when "up" pulses and "down" pulses should be generated. Monitoring is accomplished by "ANDing" the differentiated waveform edges with the original waveform using the circuit arrangement provided by U20 and U23.

4.7.5 To increase the resolution of the "count" input signals from an encoder, a pulse is generated on the rising and falling edge of each square wave. This, in effect, provides two counts for every square wave cycle and represents the multiplier symbol shown in the block diagram. The circuits of U21 and U24, clocked with an RC time constant, provide a differentiation action. The encoder inputs are passed through Schmitt triggers with a low pass filter (using U26 with RC inputs) to provide increased noise rejection.

4.7.6 Direction sensing logic (provided through U20 and U23) generate two signals which do not occur simultaneously. These signals are the CW pulse train and the CCW pulse train. These signals are applied to the up/down counters as "up" counts or "down" counts, respectively.

4.7.7 Microprocessor command selects the appropriate steering logic that determines which group of up/down counters will receive the pulses. These gated signals are shown mnemonically on the drawings as AUP and ADWN for counter Group A, or BUP and BDWN for counter Group B (refer to U22, pins 1 and 2, or U19, pins 3 and 11, for example). The microprocessor is prevented from switching counters while a count pulse is in transit through steering logic control. Steering logic is prevented from switching by application of up/down pulses to U16, pins 1 and 12. Up pulses are delayed by resistor R7, capacitor C5, and circuits of U25 while down pulses are delayed by resistor R8, capacitor C6, and circuits of U25. This signal conditioning is maintained until the steering logic is inhibited.

4.7.8 Two sets of up/down counters are provided. Counter Group A (circuits of U1, U3, and U7) and counter Group B (circuits of U4, U6, and U10) provide a 12-bit input to the microprocessor.

While one counter group is being read and reset by the microprocessor, the second group is accumulating counts. The typical steps performed by the microprocessor are as follows:

1. Select counter Group B to receive counts.
2. Read counter Group A into microprocessor memory.
3. Reset counter Group A.
4. Calculate an error voltage based on counts received from Group A.
5. Output a digital error word to the digital-to-analog converter storage register.
6. Repeat Steps 1 through 5 with the opposite Group.

4.7.9 It should be noted that the counters are not reset to "zero" counts but are "pre-set to midrange". This permits the up and down counts to add or subtract from a pre-set value. If a counter is read while containing only the pre-set value, the microprocessor determines that either (1) no counts were received during this period, or (2) that an equal number of up and down counts were received.

4.7.10 Storage of a digital error for the digital-to-analog converter is provided in the circuit arrangement of U13 and U14. The digital-to-analog converter, U12, receives 10-bits from storage and generated an analog output to U15. Operational amplifier U15 has a fixed gain and an adjustable offset. The output of U15 is applied to the Pen/Chart Servo Driver printed circuit board (A2A2) located in the Power Supply Assembly (A2).

4.8 PEN/CHART SERVO RATE LOOP PRINTED CIRCUIT BOARD ASSEMBLY (A3A11)

4.8.1 During normal operation of the Model 1581 Pattern Recorder, both the pen and chart servo encoders produce signals

which are used to generate the proper drive voltages necessary for servo motor rotation. The pen encoder will generate approximately 1200 pulses per revolution and the chart encoder will generate approximately 500 pulses per revolution. Pulses from the two encoders are applied to separate and identical circuits on the Pen/Chart Servo Rate Loop printed circuit board (A3A11). Because the circuits are identical, only one is described.

4.8.2 A simplified block diagram of our servo rate loop is shown in Figure 4-15. The typical encoder mechanism is mechanically geared to the servo motor. A system antenna positioner (or similar reference input) when moved from one point of reference to another point of reference generates an input error signal which causes the servo motor shaft in the Series 1580 Pattern Recorder to rotate. The rotation of the servo motor causes the attached encoder to generate a control signal to keep the recorder circuits synchronized with the input reference signals.

4.8.3 The encoder generated control signal is a quadrature square-wave that is coupled to the Servo Rate Loop printed circuit board through one of two lines. One carries the clockwise rotation signal and the second carries the counterclockwise signal. Only one signal will be present at a given time. The generated signal varies in frequency according to the rotational speed of the servo motor.

4.8.4 An input signal to the Servo Rate Loop printed circuit board is first divided by two in the circuits of U1. The output frequency is then applied to a frequency-to-voltage converter circuit using components U2 and U3. The converter changes the variable frequency square-wave signal into an analog voltage proportional to the frequency. This analog signal is then summed and amplified by the circuits of U4.

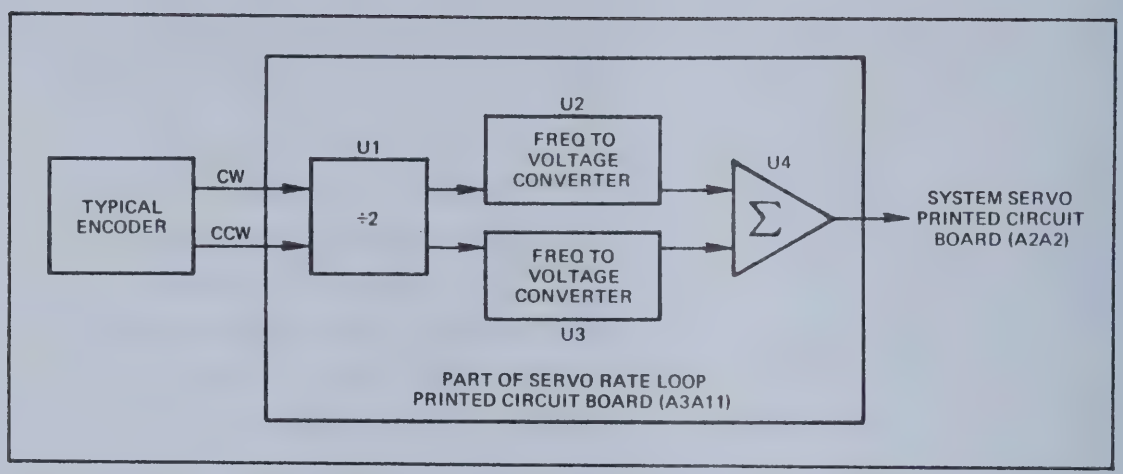


Figure 4-15. Servo Rate Loop Printed Circuit Board Assembly (A3A11), Simplified Block Diagram

4.8.5 The output voltage of U4 will be positive or negative depending upon the rotational direction of the servo motor. Amplitude of the output voltage will be proportional to the speed of the servo motor. The output voltage is coupled to the Servo System printed circuit board (A2A2) for further processing. In summary, the Rate Loop circuit provides the stability necessary for a critically damped servo loop.

4.8.6 Address decoding is provided by the circuits contained in U9.

4.9 SYSTEM SERVO PRINTED CIRCUIT BOARD ASSEMBLY (A2A2)

4.9.1 The System Servo printed circuit board (A2A2) amplifies the analog output signal from the Servo Rate Loop printed circuit board (A3A11). Components contained on the System Servo printed circuit board provide two identical amplifiers; one for the pen servo system and one for the chart servo system. Because of the similarity, only one circuit will be described. Figure 4-16 shows a simplified schematic of the servo system circuits.

4.9.2 Rotation of the recorder servo motor causes the attached encoder to generate signals through the Servo Rate Loop printed circuit board (A3A11), previously described. The analog voltage input from the Servo Rate Loop circuit is applied as the "RATE IN" signal. Both the "ERROR IN" and "RATE IN" signals are summed together in amplifier A2U1 which controls the operation of transistors A2Q1 and A2Q2.

4.9.3 Both the +26 volt and -26 volt dc power sources are connected into the System Servo printed circuit board. Diodes A2CR5 through A2CR9 are steering diodes for the positive source while diodes A2CR10 through A2CR14 are steering diodes for the

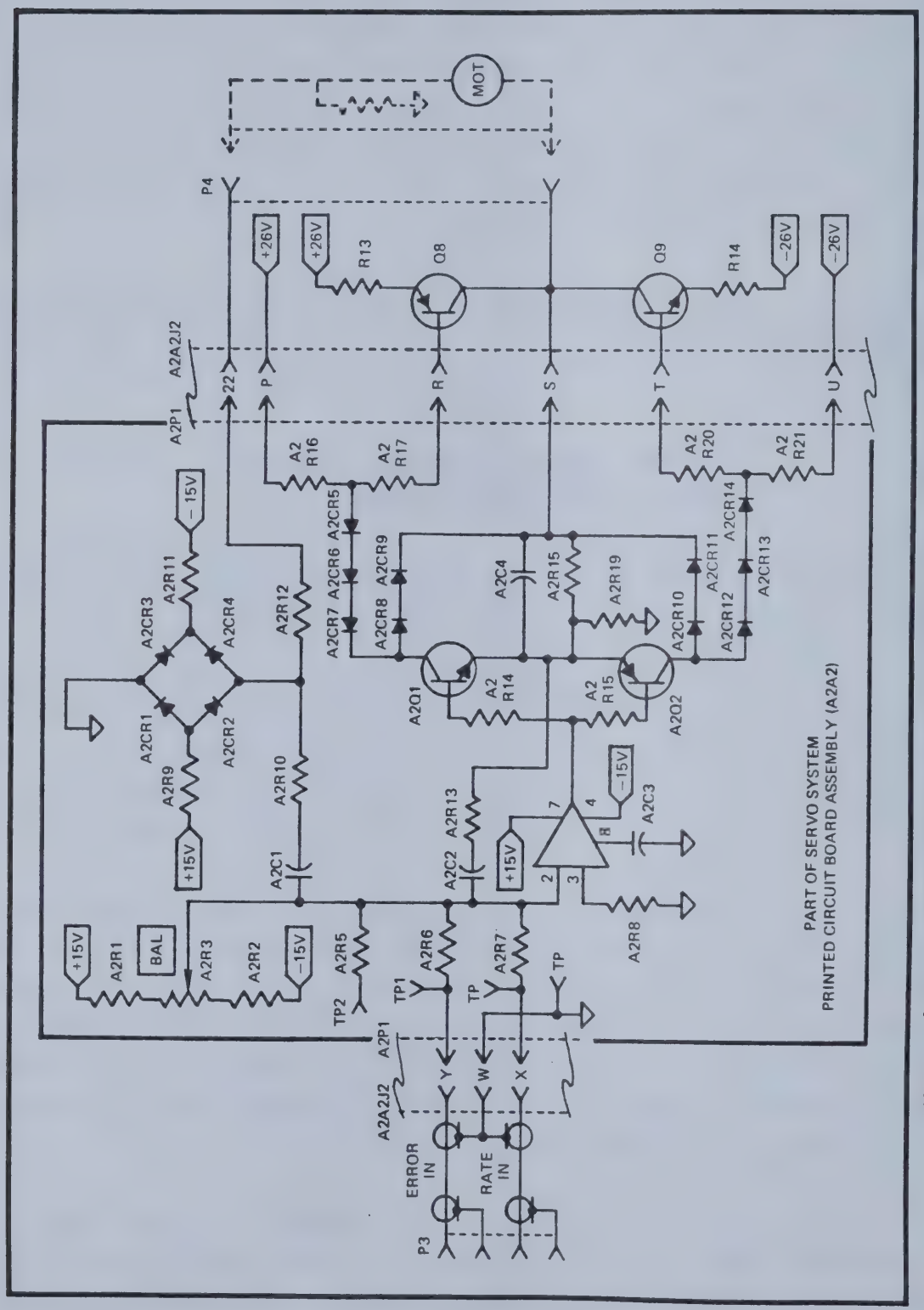


Figure 4-16. System Servo Printed Circuit Board, Simplified Schematic

negative source. As the ERROR IN signal and RATE IN signal are summed in amplifier A2U1, the resulting output will be either a positive or a negative voltage. A positive voltage output from A2U1 enables transistor A2Q1 to impress a positive voltage on the base of Q8. Similarly, a negative voltage output from A2U1 enables transistor A2Q2 and impresses a negative voltage on the base of Q9.

4.9.4 Transistors Q8 and Q9 are mounted to the power supply frame for heat sinking and are the drivers for supplying necessary current for the servo motor.

4.9.5 Another circuit assist to overcome motor inertia is provided through the diode bridge using A2CR1 through A2CR4. The bridge is balanced between the positive and negative 15 volt source supplies with one leg at common potential. The opposite leg connects to the system servo motor feedback loop through resistors A2R10, A2R12, capacitor A2C1, and connector A2P1. When the System Servo printed circuit board components become unbalanced because of an applied ERROR IN signal, the difference, either positive or negative, is coupled through capacitor A2C1 and resistor A2R10. This difference signal causes an unbalance of the diode bridge (A2CR1 through A2CR4) and provides an error voltage to the system servo motor. This voltage is not sufficient to drive the servo motor, but the voltage impressed across the motor coils reduces the inertia to be overcome and start the motor rotation. This allows the servo motor to respond to a very small error signal almost simultaneously with application at the input.

4.10 DIGITAL INTERFACE PRINTED CIRCUIT BOARD ASSEMBLY (A3A5 OR A3A6)

4.10.1 The Digital Interface printed circuit board (A3A5 for a Pen input interface or A3A6 for a Chart input interface) is designed to serve for either function. When used as a Pen input interface, the Model 1581 Pattern Recorder may be connected to either a Series 1800 Ratiometer or to a Digital Phase unit (which provides either a byte or parallel output). When used as a Chart input interface, the Model 1581 Pattern Recorder may be connected to a Series 1840 Digital Synchro Display which provides both a byte and parallel output.

4.10.2 Cables used for interconnection between the digital test equipment and the Model 1581 Pattern Recorder are coded using jumper wires which identify the test equipment connected and if the input signals are byte or parallel format.

4.10.3 Microprocessor addressing to the Digital Interface printed circuit board is accomplished by proper connection wiring on the motherboard. The following description is best understood by referring to the schematic diagram. See Figure 7-36.

4.10.4 The Digital Interface printed circuit board has six lines outbound and 24 lines inbound. The six lines outbound are used to enable byte select data for byte interface and to inhibit the test equipment during the time interval when the interface is being read. Byte select signals are stored in the circuits of U7 after being buffered by the circuits of U1.

4.10.5 The 24 lines inbound are used to transfer data from the test equipment onto the microprocessor Data Bus. The data is gated onto the Data Bus through circuits of U8, U9, and U10. Addressing the Digital Interface printed circuit board by

the microprocessor is performed through the circuits of U6 and U11, while noise is filtered from the Read Address Bus by the operation of U5 and capacitors C6 and C7.

4.11 CBA/DCA INTERFACE PRINTED CIRCUIT BOARD ASSEMBLY (A3A5)

4.11.1 The CBA/DCA Interface printed circuit board (A3A5) is an optional circuit which is necessary when the Series 1580 Pattern Recorder is to be used with either the Model 1586 Crystal-Bolometer Amplifier unit or the Model 1587 DC Amplifier unit. The CBA/DCA Interface printed circuit board changes analog input signals to digital equivalents acceptable to the operation of the Series 1580 Pattern Recorder. A simplified block diagram of the CBA/DCA Interface printed circuit board is shown in Figure 4-17.

4.11.2 The CBA/DCA Interface printed circuit board accepts an analog signal from either a Model 1586 Crystal-Bolometer Amplifier or a Model 1587 DC Amplifier. The analog input signal is converted into a 12-bit binary digital signal proportional to the analog signal in the Analog-to-Digital (A/D) Converter (U3). The digital output signals from the A/D Converter (U3) are applied to and stored in the 3-State Line Driver circuits (U1 and U2) until the microprocessor signals for them.

4.11.3 The microprocessor controls the A/D Converter (U3) operation by first applying a START pulse through the timing logic arranged by gates in U4, U5, and U6. After the START pulse is applied, the microprocessor reads the STATUS OUT condition on U3, pin 20 (shown in detail on Figure 7-32). If the STATUS OUT condition is acceptable, the digital signals stored in U1 and U2 are placed on the Data Bus. This delay allows for all amplifiers

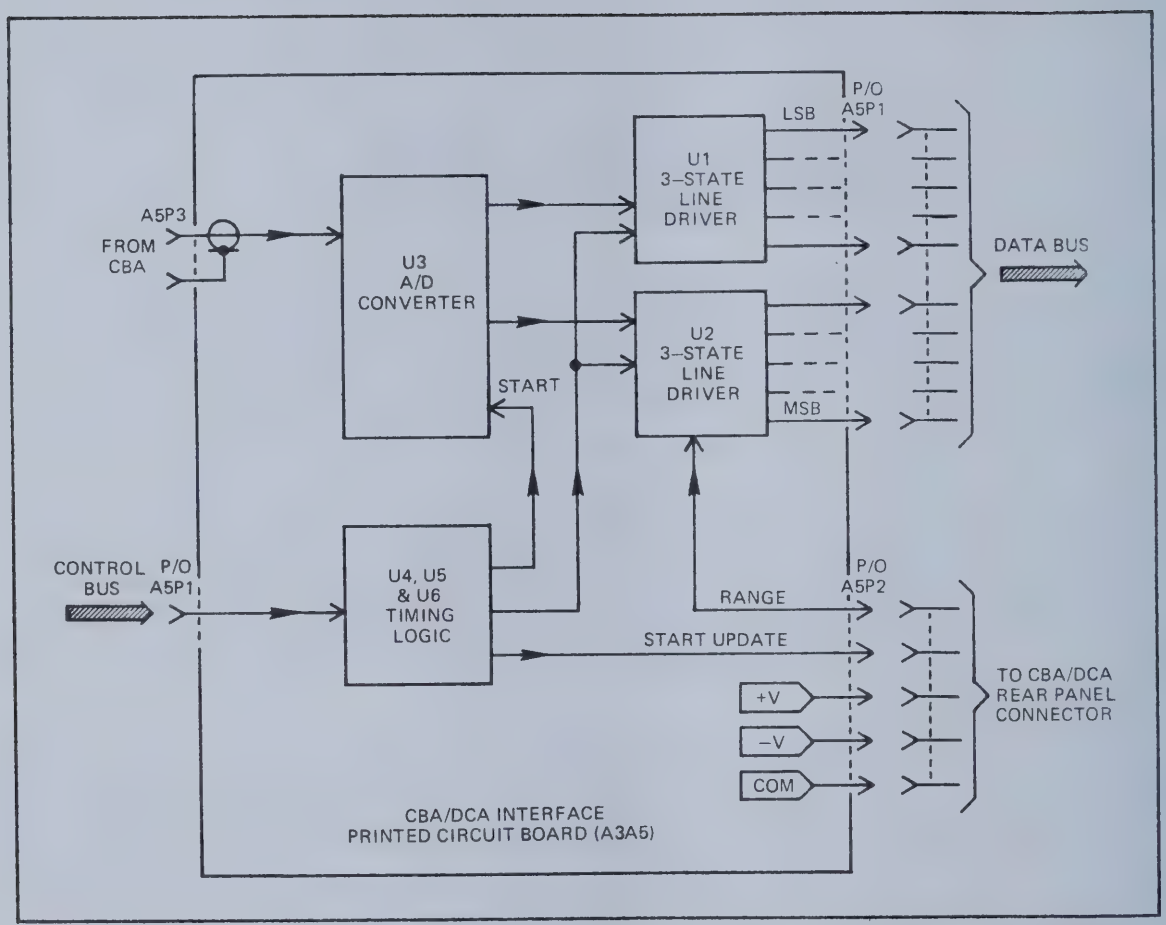


Figure 4-17. CBA/DCA Interface Printed Circuit Board Assembly (A3A5), Block Diagram

preceding the A/D Converter (U3), plus the circuits contained in U3, to become settled before a reading is taken..

4.11.4 The connected Model 1586 Crystal-Bolometer Amplifier or Model 1587 DC Amplifier provides the circuits of the CBA/DCA Interface printed circuit board with a signal identifying a selected RANGE through connector A5P2. In turn, the microprocessor sends out a START UPDATE command through the Timing Logic circuits (U4, U5, and U6) and connector A5P2 to maintain signal synchronization with other functions being performed within the Series 1580 Pattern Recorder.

4.11.5 Also note that all dc operating voltages and respective common returns are supplied through connector A5P2 to either a connected Model 1586 Crystal-Bolometer Amplifier or a Model 1587 DC Amplifier.

4.12 SYNCHRO-TO-DIGITAL (S/D) CONVERTER PRINTED CIRCUIT BOARD ASSEMBLY (A3A6) AND S/D TRANSFORMER (A5)

4.12.1 The Synchro-to-Digital (S/D) Converter printed circuit board (A3A6) and the S/D Transformer (A5) are optional equipment. When the Series 1580 Pattern Recorder is used to plot angular position from a rotational reference source such as a synchro transmitter, both the S/D Transformer (A5) and the S/D Converter printed circuit board (A3A6) are required. The S/D Transformer (A5) is mounted on the rear panel of the Series 1580 Pattern Recorder and the S/D Converter printed circuit board (A3A6) must be inserted into the A3A12A6 location within the printed circuit board cage.

4.12.2 A single synchro transmitter source can be connected directly to the S/D Transformer (A5) or a Model 1588 Synchro Selector unit can be used to interface up to four synchro sources. The synchro sources can be either a 36:1 or 1:1 ratio but only one source at a time can be input to Series 1580 Pattern Recorder circuits. The Model 1588 Synchro Select unit provides switch selection convenience for obtaining recorded information.

4.12.3 Analog synchro signals, representing either a 36:1 or 1:1 ratio is applied to the input of S/D Transformer (A5). The transformer couples the low level signals through an interconnecting flat ribbon cable to connector A3A6P2 on the S/D Converter printed circuit board (A3A6).

4.12.4 The low level analog synchro signals are converted into a 10-bit binary word through U1 for output to the microprocessor Data Bus. Gating the output of U1 onto the Data Bus is performed through the operation of gates U4 and U5.

4.12.5 When using a single synchro source directly into the S/D Transformer (A5), a definite arrangement of shorting straps must also be included to the mating connector which will identify the synchro ratio to the internal circuits. The mating connector for input jack J2 should be an AN3106A-14S-2P, or equivalent. Shorting pin A to pins B and C on the mating connector conditions the S/D Transformer (A5) to properly operate with a 1:1 ratio synchro input. Leaving pin A open on the mating connector conditions the S/D Transformer (A5) to properly operate with a 36:1 ratio synchro input.

4.12.6 Pin C of input connector J2 on the S/D Transformer (A5) permits the Model 1588 Synchro Selector unit to indicate when a synchro input source is being switched. When this occurs, the Series 1580 Pattern Recorder microprocessor ignores the synchro input until the data has had time to settle. Addressing

of the S/D Converter circuits is performed through circuits using U6 and U7 and the inhibit function is performed through circuits using U3.

4.13 60 DB OPTION PRINTED CIRCUIT BOARD ASSEMBLY (A3A8)

4.13.1 The 60 dB Option printed circuit board (A3A8) can be used to expand the range of operation when input signals are provided from a Model 1711 Microwave Receiver. Circuit design provides an analog feedback signal, which is proportional to the pen position, to the Model 1711 Microwave Receiver through connector J4 located on the Recorder Option Panel. The analog feedback signal is used to control the IF gain in the receiver which permits a 60 dB dynamic range to be realized over a normal 40 dB dynamic range response.

4.13.2 When the Model 1581 Pattern Recorder PEN FUNCTION is LOG and the PEN SCALE is 80 dB, the pen value is mathematically scaled and output in digital form to storage in the circuits of U1 and U2. The digital data is converted to analog by the 10-bit digital-to-analog converter circuits provided in U2. An operational amplifier in U3 provides the feedback drive signal through connector P2. The analog voltage offset is adjustable with variable resistor R4 and the analog voltage gain is adjustable with variable resistor R8.

4.13.3 Normal analog voltages are 0 volts for 0 dB pen position and +6.0 volts for 60 dB (full scale) pen position when feedback is being input to the Model 1711 Microwave Receiver.

4.14 IEEE-488 INTERFACE OPTION PRINTED CIRCUIT BOARD ASSEMBLY (A3A7)

4.14.1 The IEEE-488 Interface Option printed circuit board (A3A7) permits remote programming of the Series 1580 Pattern Recorder through the provisions and functions of the IEEE-488 Digital Interface Bus. All communications from the Series 1580 Pattern Recorder onto the IEEE-488 Digital Interface Bus are made through a Motorola MC 68488 General Purpose Interface Adapter (hereafter abbreviated as GPIA) shown in the schematic, Figure 7-38 as U6.

4.14.2 A simplified block diagram of the IEEE-488 Interface Option printed circuit board (A3A7) is shown in Figure 4-18. The GPIA handles Data Bus protocol and timing as specified by the IEEE Standard 488-1975. (For further information, refer to the IEEE Standard titled "IEEE Standard Digital Interface for Programmable Instrumentation".) Bus transceiver circuits using gates U1, U2, U3, and U4 provide the actual bus interface with voltage levels as specified by the IEEE Standard.

4.14.3 The GPIA is interfaced through 3-state gates (U17 and U19) and storage registers (U20 and U21) into the Series 1580 Pattern Recorder microprocessor. Communication with the microprocessor is through a mapped memory I/O technique. Dedicated "read" and "write" addresses are assigned to the IEEE-488 Interface Option printed circuit board. The address decoding is performed by the circuits using U22. Basic timing is accomplished by dividing the Ø3TTL clock signal from the recorder microprocessor bus in circuits using U14 and U15 and synchronizing the GPIA Select function with the Clock Output provided from U14, pin 2.

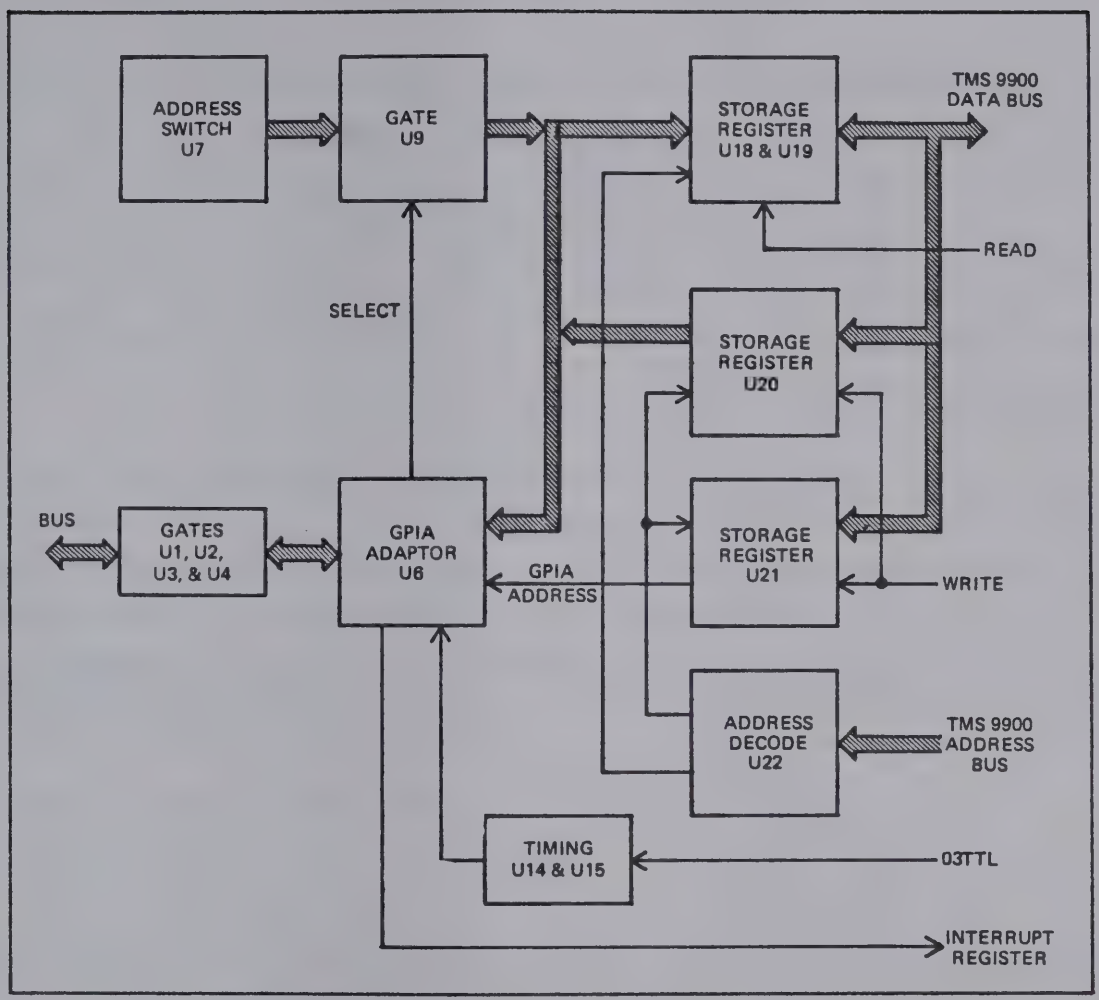


Figure 4-18. IEEE-488 Interface Option Printed Circuit Board Assembly (A3A9), Block Diagram

4.14.4 Synchronization is performed by flip-flops U11-A and U11-B. Flip-flop U11-A is triggered and arms U11-B on receipt of a read or write request. At the next appropriate clock occurance, U11-B is toggled and generates a circuit select signal for the GPIA. The total time duration from initial arming of U11-B to the reset of U11-B and the end of the cycle is "ORed" at U10-6 and represents the "BUSY" time of the GPIA interface. This "BUSY" signal can be monitored at test point TP2 and the GPIA clock signal can be monitored at test point TP1. These waveforms are shown in Figure 4-19.

4.14.5 Data to be entered on the microprocessor data bus through the IEEE-488 Option printed circuit board is latched into the circuits of U20 and U21. The data byte input to the GPIA is latched into U20 while the GPIA address is latched into U21. The 3-state gate, U17, permits disconnecting storage register U20 from the GPIA 8-bit data bus during a "READ" operation.

4.14.6 Output bytes from the GPIA are latched in the storage register circuits of U16. Data bytes are then placed on the microprocessor Data Bus by the address enabling of the 3-state gates U18 and U19.

4.14.7 A device address is selected by setting the switches on the dip (dual inline pin) switch assembly U7. The device address is read on command by addressing the GPIA which, in turn, outputs an enable to gate U9. The switch assembly contents are then strobed into the storage register U16 and then read by the microprocessor.

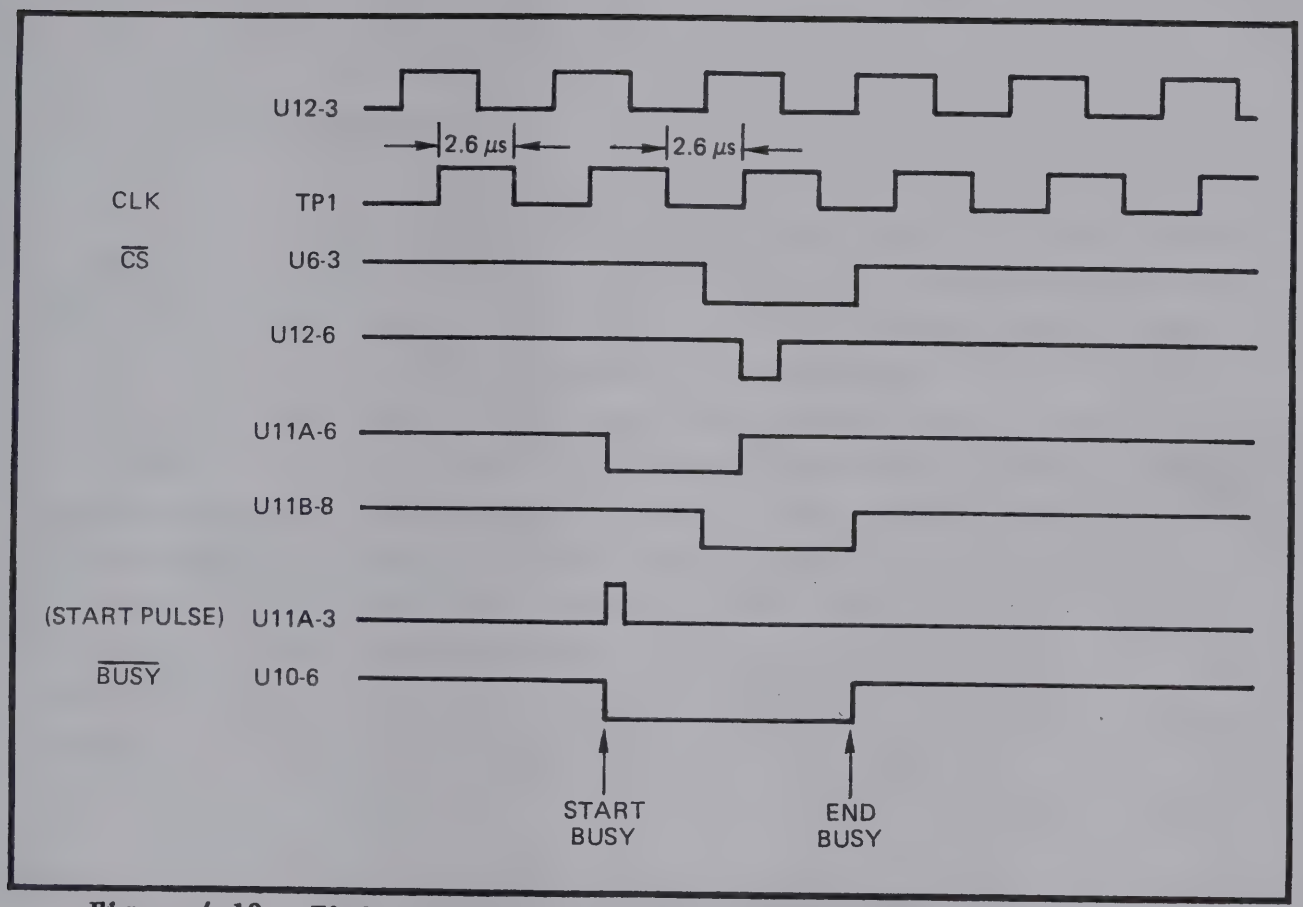


Figure 4-19. Timing Waveforms Typical of Normal IEEE-488 Interface PCB Operation

CHAPTER 5
MAINTENANCE

5.1 GENERAL

5.1.1 Due to the nature of the equipment and the inherent reliability of components used in manufacture, frequent periodic maintenance and alignment of the Scientific-Atlanta Series 1580 Pattern Recorder is not necessary or recommended. It is recommended, however, that all accessories, options and the main unit be inspected and calibrated by Scientific-Atlanta personnel or representatives on a quarterly basis. This action will insure that the equipment will meet all published specifications and provide the user with trouble free, accurate performance. The nearest Scientific-Atlanta representative or the nearest Regional Service Center can arrange for such factory calibration. Region Service Centers are listed on the last page of this chapter.

5.2 ELECTRONIC TROUBLESHOOTING

5.2.1 The intent of this section is to enable the technician to repair equipment out of warranty by locating and identifying defective modules and/or printed circuit boards. Once the defective module and/or printed circuit board has been isolated, either a pre-tested replacement unit may be obtained from Scientific-Atlanta or further troubleshooting may be performed within the circuits.

5.2.2 This section is arranged in a logical sequence of basic procedures designed to isolate a fault within a malfunctioning Series 1580 Pattern Recorder. It is suggested that prior

to troubleshooting within a module and/or printed circuit board that the technician review thoroughly the applicable section in the Theory of Operation, Chapter 4, and the appropriate schematic.

5.2.3 While it is not possible to describe all the possible failure modes of a Series 1580 Pattern Recorder with various options and accessories, there are basic steps which can be performed to locate and isolate malfunctions. These basic steps are shown in Figure 5-1 as a troubleshooting flow chart to serve as a general guide.

5.2.4 The recommended tests should be performed and verified using a Fluke 8000A Digital Volt Meter (DVM) for voltage and resistance measurements and a Tektronix 475 Oscilloscope to observe waveform patterns. Equivalent or better test equipment may be substituted when necessary.

5.3 PRELIMINARY CHECKOUT

5.3.1 Before starting into flowchart procedures to analyze a malfunction, first check the Series 1580 Pattern Recorder Power Supply (A2) and the Microprocessor functions (Central Processing Unit printed circuit board A3A2 and Main Memory printed circuit board A3A3). Normal operation of all recorder functions are initially controlled from these two sources.

5.3.2 Perform the preliminary checkout using the following procedures in sequence. The sequence is also illustrated in a flowchart form shown in Figure 5-1.

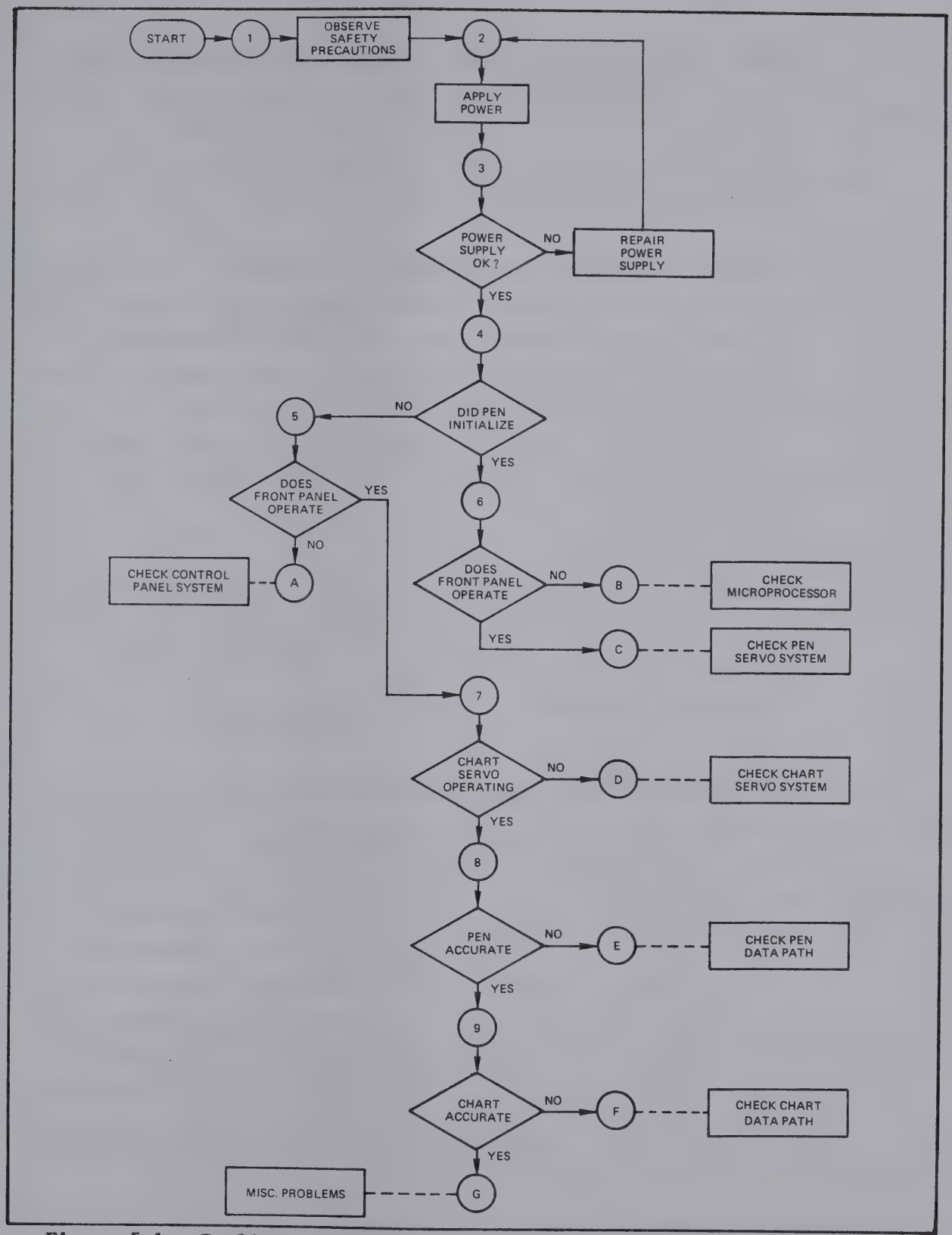


Figure 5-1. Preliminary Checkout Procedures, Maintenance Troubleshooting Flowchart 1

1. Measure ac source supply voltage and note that the Series 1580 Pattern Recorder is properly conditioned to operate from the ac source. When this requirement is met, apply ac power to the recorder. Observe the front panel POWER ON-OFF switch is positioned to OFF.

2. Remove the Power Supply cover. Remove the Regulator printed circuit board (A2A1), insert the 131225 printed circuit board extender into the empty connector, and reconnect the Regulator printed circuit board to the system circuits through the extender socket. Be sure the component side of the Regulator printed circuit board is properly oriented. Operate POWER ON-OFF switch to ON.

3. Measure the power supply voltages. Make the necessary adjustments and/or repairs for all voltages out of tolerance. If all measurements indicate normal operation, proceed to Step 4.

Requirements:

Voltage	Tolerance	Measure Between	If Necessary, Adjust
+15V dc	±0.1V	TP-1 TP-2(com)	Resistor R4
-15V dc	±0.1V	TP-3 TP-2(com)	Resistor R9
+5.0V dc	±0.1V	TP-4 TP-5(com)	Resistor R16
+26V dc	±0.2V	TP-6 TP-7(com)	Resistor R24
-26V dc	±0.2V	TP-8 TP-7(com)	Resistor R31
+12V dc	±0.6V	U2-2 U2-Case	Non-Adjustable
-5.0V dc	±0.20V	U1-2 U1-1	Non-Adjustable

4. Observe that the recording pen provides a small movement when the POWER ON-OFF switch is positioned from OFF to ON. If an initial movement is observed, this is a preliminary indication that the microprocessor circuits (A3A2 and A3A3) are providing some operational signals.

   Requirements:

   a. If the pen is observed to move, proceed to Step 6.
   b. If the pen does not move, proceed to Step 5.

5. Check front panel switches for visual indications. Operate various front panel switches having associated indicators and observe changes as the switch position is changed.

   Requirements:

   a. If the front panel indicators change with switch position changes but normal operation is not provided, proceed with Step 6.
   b. If the front panel indicators do not operate, proceed to Section A and perform Control Panel Checkout.

6. At this step of testing, either the pen did not provide an observable movement when the POWER ON-OFF switch is positioned to ON, or further testing with front panel indicators is required. It is necessary to determine if the problem is in the pen servo system or if the microprocessor has failed. If necessary, operate the POWER ON-OFF switch to ON and then operate

front panel switches having associated indicators. Observe that the illuminated indicators follow the switch position changes.

Requirements:

a. If the front panel indicators can be advanced, the microprocessor is working and the malfunction is related to the pen servo system. Proceed to Section C and perform Pen Servo System Checkout.

b. If the front panel indicators do not follow as the switch position is changed, proceed to Section B and perform the Microprocessor Checkout.

7. Test that the Chart Servo System is operating. If necessary, operate the POWER ON-OFF switch to ON. Operate the CHART DIRECTION FWD-OFF-REV switch one direction and then the opposite direction. If the chart paper moves normally, the Chart Servo System is operating. Proceed to Step 8.

Requirements:

a. If the chart paper does not move with any chart movement commands (i.e., the CHART DIRECTION FWD-OFF-REV switch positioned to either RWD or REV and other chart function switches are operated) proceed to Section D and perform the Chart Servo System Checkout.

b. If some chart controls cause chart paper movement while others do not, the malfunction

may be related to the control panel interface. Proceed to Step A and perform the Control Panel System Checkout.

8. At this step of testing, the pen servo system has been determined to be operating. Carefully observe if the pen position appears to be accurate (i.e., does it approximately agree with the pen input information).

   Requirements:

   a. If the pen position can be judged to be approximately correct, proceed to Step 9.
   b. If the pen position is judged to be inaccurate, proceed to Section E and perform the Pen Data Path Checkout.

9. At this step of testing, the chart servo system has been determined to be operating. Carefully observe if the chart position appears to be accurate (i.e., does the chart paper movement follow chart input data correctly).

   Requirements:

   a. If the chart servo system appears to follow chart input data correctly but a malfunction is still suspect, proceed to Section G and perform tests for Miscellaneous Problems.
   b. If the chart position is identified to be inaccurate, proceed to Section F and perform the Chart Data Path Checkout.

5.4 SECTION A: CONTROL PANEL SYSTEM CHECKOUT

5.4.1 This section is an abbreviated checkout test of the Series 1580 Pattern Recorder using the front panel switches and indicators to determine a malfunction. A technician using the procedures in this Section should have a good knowledge of microprocessor operation as well as test equipment techniques.

5.4.2 The following procedures should be followed in sequence. If, during testing, troubleshooting leads into other circuits and/or subassemblies before being accepted as normal for the present condition, return to the procedure step and continue the sequence to the end. This should provide the most rapid isolation of a suspected malfunction. The Control Panel System Checkout procedures are illustrated in a flowchart form shown in Figure 5-2.

A. CONTROL PANEL SYSTEM CHECKOUT

1. Observe that the Panel Control Interface printed circuit board (A3A1) is properly and securely installed in the Motherboard (A3A12).

2. Carefully check the four cables connecting the Panel Control Interface printed circuit board (A3A1) to the Chart Control Panel (A1A4), the Pen Control Panel (A1A3), and the Pen Calibrate printed circuit board (A1A2) assembly. All cable connections must be tight and keyed correctly.

3. As the microprocessor reads the Panel Control Interface printed circuit board (A3A1), addresses are generated which select which gates will be enabled onto the data

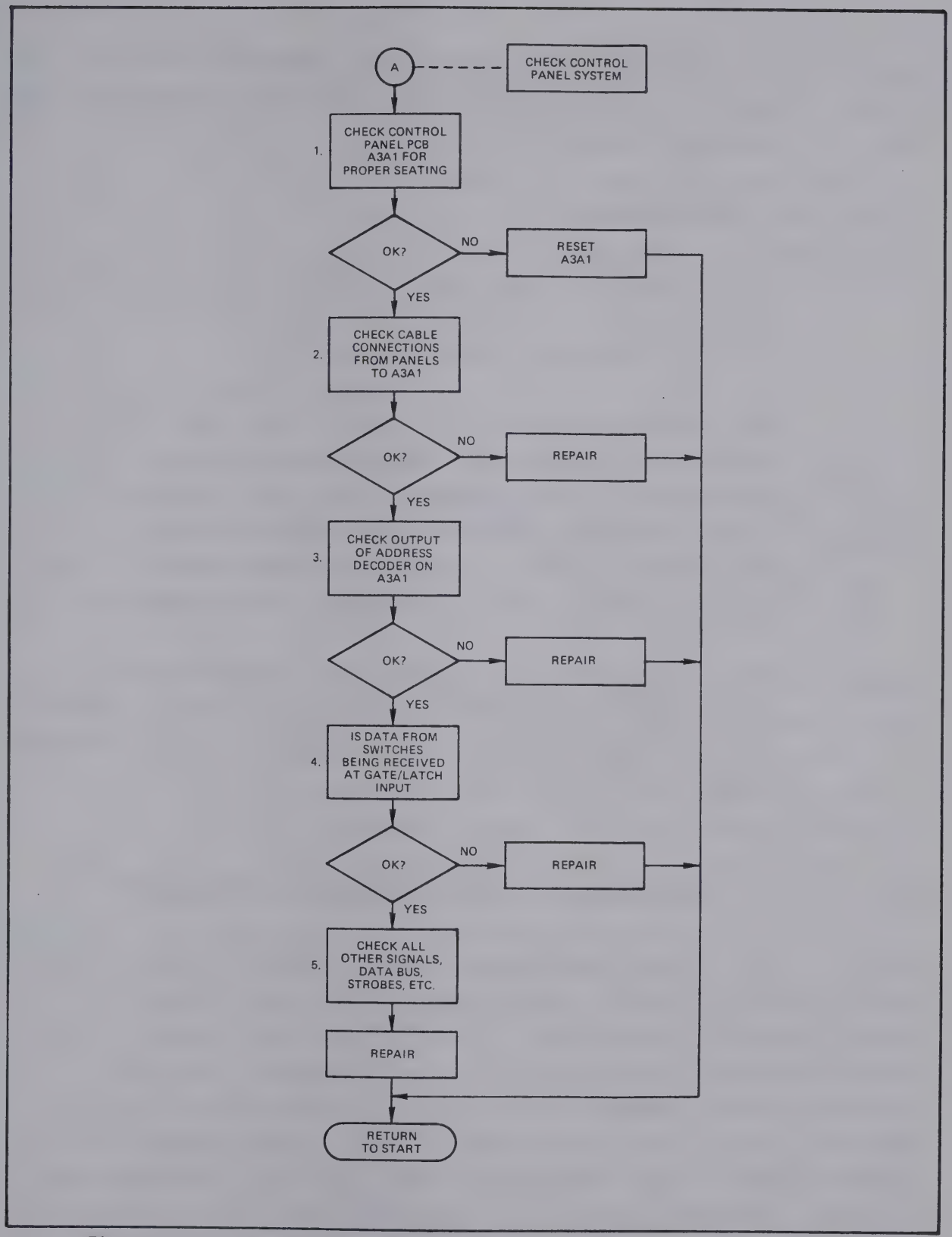


Figure 5-2. Control Panel System Checkout Procedures, Maintenance Troubleshooting Flowchart 2

bus. Use the oscilloscope and check the Address Decoder (U15) output on Panel Control Interface printed circuit board (A3A1).

Requirements:

Pins 15, 14, 13, and 12 of U15 should normally be high. As an address is decoded, a ground of 2 µs duration should be generated.

4. Use the oscilloscope and observe that data from the front panel switches is being received at the gate/latch inputs. For example, pin 15 of U10 should be "low" when CHART MODE FULL-HALF-POLAR switch is positioned to FULL. Check all signal inputs to confirm data paths from front panel switch contacts.

5. Check other control signals such as DBIN (Data Bus In) and $\overline{WE}$ ($\overline{Write\ Enable}$). The DBIN signal is normally "low" and pulses "high", or the $\overline{WE}$ signal is normally "high" and pulses "low".

5.5 SECTION B: MICROPROCESSOR CHECKOUT

5.5.1 Actual troubleshooting of the CPU (Control Processing Unit) printed circuit board (A3A2) and the Main Memory printed circuit board (A3A3) is best performed by substitution using printed circuit boards known to be good. Instructions for execution by the microprocessor on the CPU printed circuit board are obtained from the Main Memory printed circuit board. Hard failures are not difficult to isolate to a single component such as a clock oscillator or an inoperative gate.

5.5.2 Intermittent failures are more difficult to isolate due to the nature of the digital processor system. Therefore, substitution of printed circuit boards to rapidly isolate malfunctions is highly recommended. Be sure the front panel POWER ON-OFF switch is positioned to OFF before starting the checkout procedure. The Microprocessor Checkout procedures are illustrated in a flowchart form shown in Figure 5-3.

B. MICROPROCESSOR CHECKOUT

1. Carefully check that the CPU printed circuit board (A3A2), the Main Memory printed circuit board (A3A3), and the Optional Memory printed circuit board (A3A4), if present, are all properly and securely installed in their respective Motherboard (A3A12) connectors.

2. Remove the CPU printed circuit board (A3A2) and insert the Scientific-Atlanta Part No. 158463 printed circuit board extender into the empty connector. Reconnect the CPU printed circuit board to the system circuits through the extender socket. Be sure the CPU printed circuit board is properly oriented. Operate the front panel POWER ON-OFF switch to ON. Use the oscilloscope and observe the 4-phase clock waveform to be as shown below. These clock signals must <u>all</u> be present for the microprocessor to operate.

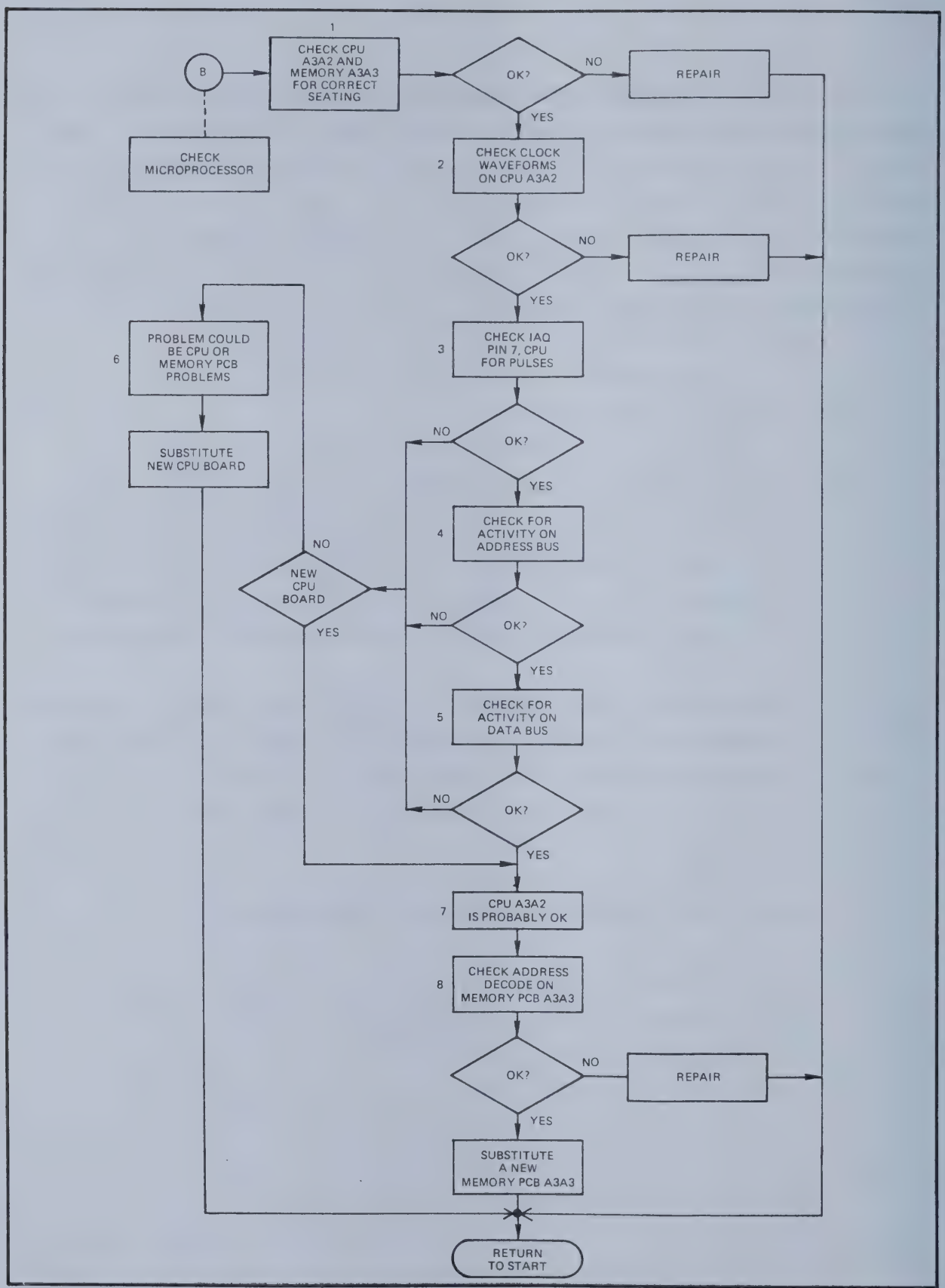
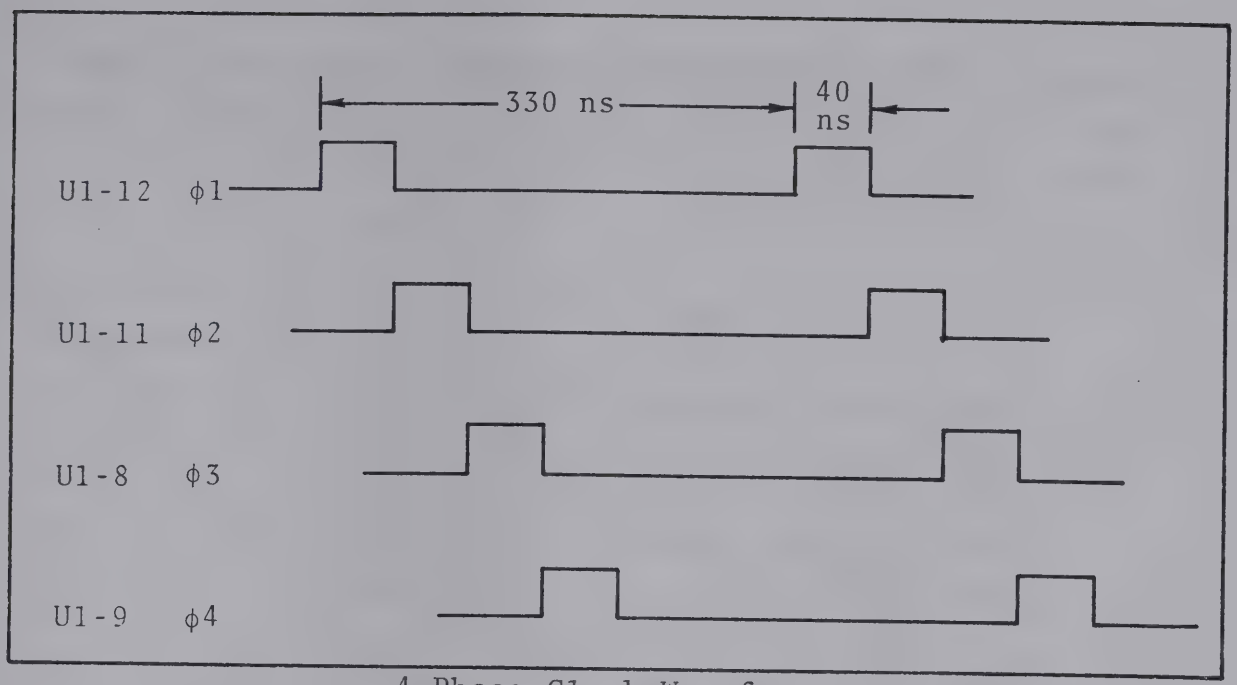


Figure 5-3. Pen Servo System Checkout Procedures, Maintenance Troubleshooting Flowchart 3



4-Phase Clock Waveforms

3. Check the Instruction Acquisition (IAQ) signal that should appear at pin 7 of U5. The IAQ signal will be active (high) during any memory cycle when the microprocessor is acquiring information or instruction.

4. Check for activity on the CPU printed circuit board Address Bus. It will be difficult to obtain a meaningful waveform pattern at this point. Normally, it will suffice to check for output pulses from component U6. Also, check all address lines A14 through A0. The A14 line represents the least significant bit and should be the most active. Remember that address lines can have pulses at patterns that are firmware dependant and some address lines will infrequently go high. But if pulses are not observed on <u>any</u> address lines, a problem does exist.

5. Similar to Step 5, check for activity on the Data Bus. Make checks at U7, U8, U10, and U9 and check all data lines D15 through D0. When observing waveforms,

remember that the Data Bus is bidirectional. Check for a steering pulse at U2, pin 3. No definite pattern can be predicted for the Data Bus but no activity indicates problems.

6. If the preceding tests have not indicated the general location of a probable malfunction at this point, it is possible that problems indicating CPU trouble may be originating from the Main Memory printed circuit board (A3A3). It is difficult to isolate a problem to a particular printed circuit board since the CPU must be able to acquire instructions for execution from one or both memory printed circuit boards. The next procedure is to replace the CPU printed circuit board with one known to be good. Return and repeat Section B, Steps 1 through 5, inclusively. If the test results are unchanged, the original CPU printed circuit board probably is not at fault. Prepare the appropriate Memory printed circuit board for examination by proceeding with Steps 7 and 8.

7. Operate the front panel POWER ON-OFF switch to OFF. Remove the CPU printed circuit board and extender. Separate the two printed circuit boards and return the CPU to its original location. Remove the Main Memory printed circuit board and replace it with the Scientific-Atlanta Part No. 158463 extender board. Carefully reconnect the Main Memory printed circuit board to the system circuits observing proper orientation of the component side and using the extender socket. Visually scan the test arrangement for obvious faults. If all appears normal, operate POWER ON-OFF switch to ON.

8. Use the oscilloscope and check the decoding network on the Main Memory printed circuit board (A3A3). The address decoding pulse should be present at U20-15, U20-14, U18-15, U18-14, and U9-11.

NOTE

If the Optional Memory printed circuit board (A3A4) is present, Steps 7 and 8 should be repeated with the Optional Memory printed circuit board connected to the system through the Scientific-Atlanta Part No. 158463 extender. Address decoding pulses should be present at U20-13, U20-12, U18-12, and U9-11. Remember also that front panel switches requiring the presence of the Optional Memory printed circuit board, such CHART MODE-POLAR must be operated to observe the above conditions.

5.6 SECTION C: PEN SERVO SYSTEM CHECKOUT

5.6.1 The Series 1580 Pattern Recorder Pen Servo System consists of the Pen Control printed circuit board (A3A9), the Pen/Chart Servo Rate Loop printed circuit board (A3A11), the Pen Motor and Encoder (A1A1A1A1), and the Pen/Chart Servo Driver printed circuit board (A2A2). Troubleshooting procedures will attempt to isolate malfunctions to a general area by examination of the Pen System response to signal commands and system responses.

NOTE

Remember that the Pen Control printed circuit board (A3A9) and the Chart Control printed circuit board (A3A10) are identical. When necessary, the two printed circuit boards can be interchanged for test purposes.

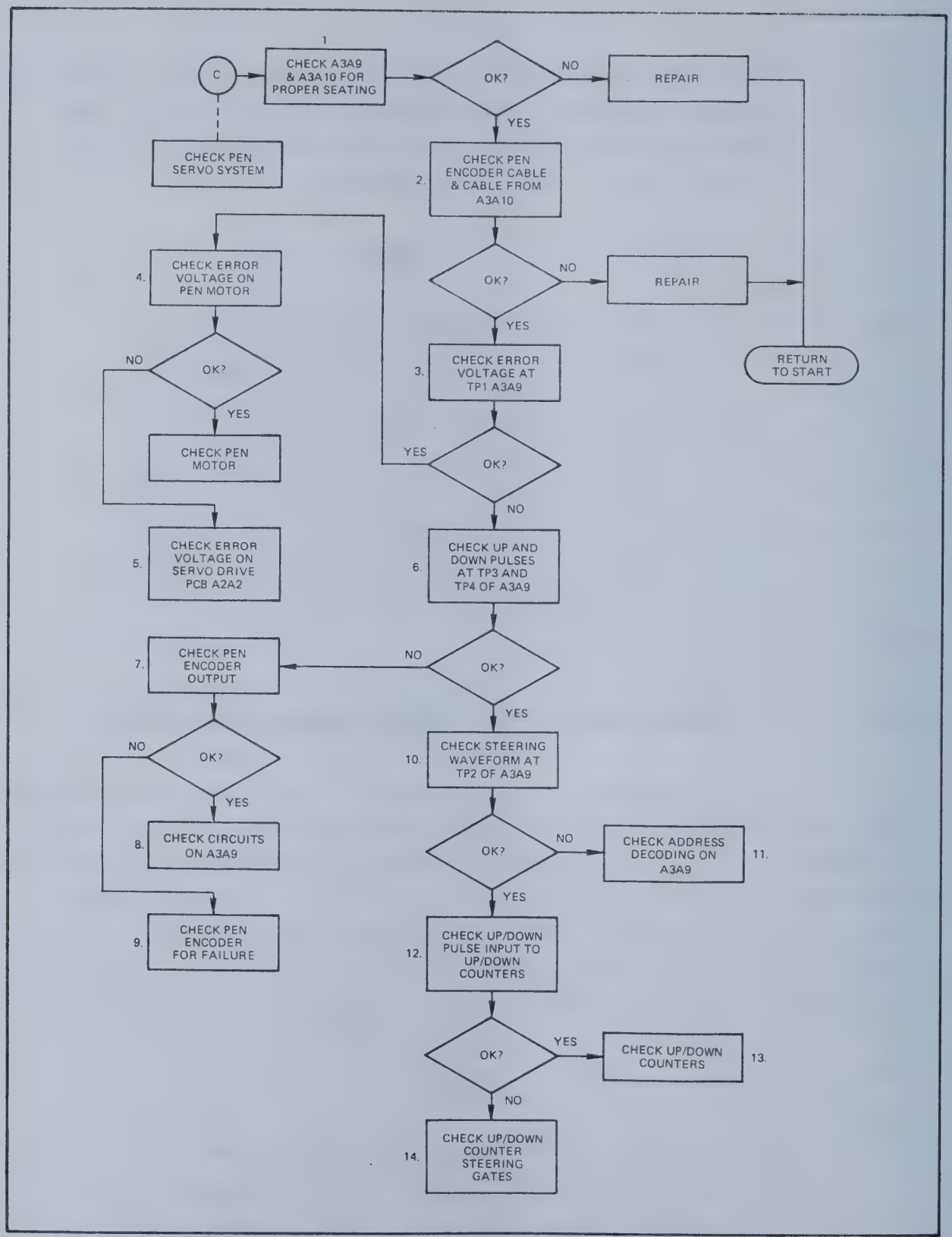


Figure 5-4. Pen Servo System Checkout Procedures, Maintenance Troubleshooting Flowchart 4

5.6.2 It can be noted that certain failures may be isolated by substitution, but actual malfunctions will be determined with conventional digital troubleshooting methods such as observing signal paths using the oscilloscope. The Pen Servo System Checkout Procedures are illustrated in a flowchart form shown in Figure 5-4.

C. PEN SERVO SYSTEM CHECKOUT

1. Before applying ac power, carefully perform a visual inspection of all printed circuit boards, especially those associated with the Pen System (i.e., positions A3A9, A3A11, and A2A2) for proper seating, cable connectors secure and oriented correctly, etc.

2. Carefully check the pen encoder cable connector (A1A1A1P1) at the Motherboard (A3A12) to be secure and properly oriented. Similarly check the A2W3 cable connections at the Pen/Chart Servo Rate Loop printed circuit board (A3A11) and at the Pen/Chart Servo Driver printed circuit board (A2A2). If all connectors check to be adequate, then operate the front panel POWER ON-OFF switch to ON.

3. Check the error voltage at test point TP1 on the Pen Control printed circuit board (A3A9) with the digital voltmeter. Refer to the section on Adjustments for proper voltages and procedures.

   If the pen error voltage measured at test point TP1 is correct, proceed to Step 6. If the measured voltage is not correct, proceed with Step 4.

4. Measure the error voltage provided to the pen motor (A1A1A1A1). The error drive voltages are provided to the pen motor from the Pen/Chart Servo Driver printed circuit board (A2A2) and will vary between 0 volts (for no error) to ±23 volts (for maximum error).

   Requirements:

   a. Absence of drive voltage to the pen motor when error voltage is measured at TP1 indicates a possible malfunction on the Pen/Chart Servo Driver printed circuit board (A2A2). Remember that the pen must be forced away from the Null for a drive voltage to be produced. This can be accomplished similar to producing error voltages at TP1 in Step 3. If pen motor error voltages are absent, proceed to Step 5.

   b. If pen motor error voltages are present but the motor does not drive, the pen motor is suspect as the source of the malfunction.

5. Check error voltages on the Pen/Chart Servo Driver printed circuit board (A2A2).

   Requirements:

   a. If error voltages are absent on test points TP1 and TP2 when the pen is forced away from Null, proceed to Step 6.

b. If error voltages appear on test points TP1 and TP2, a possible area of malfunction is on the Pen/Chart Servo Driver printed circuit board (A2A2).

6. Use the oscilloscope and measure the up and down counter pulses provided between test points TP3 and TP4 on the Pen Control printed circuit board (A3A9). A pulse width should measure approximately 350 nsec.

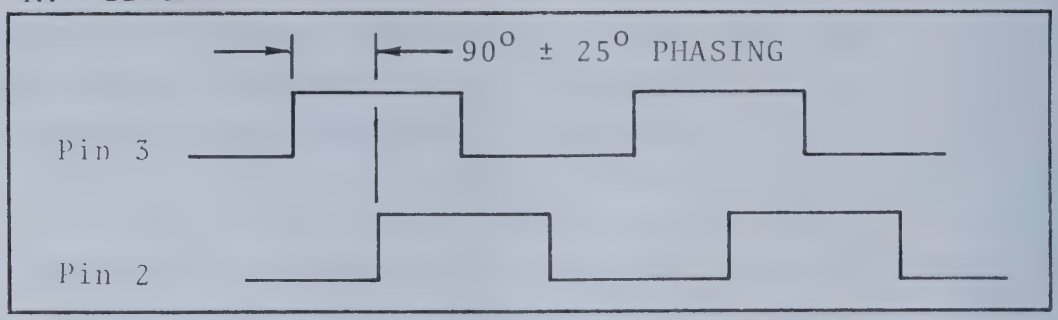
Requirements:

a. Pulse waveforms observed between test points TP3 and TP4 indicate the signal path condition from the pen motor encoder through the input buffer and multiplier circuits provided on the Pen Control printed circuit board (A3A9). Extreme deviation in the waveform width indicates a possible malfunction in this signal path.

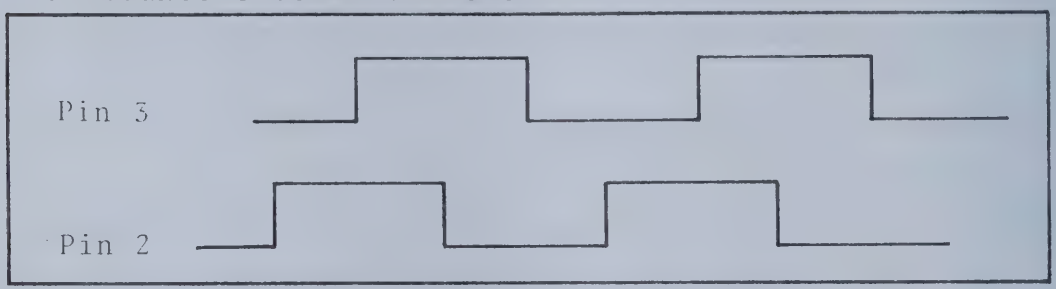
b. If waveform pulses do not appear at test points TP3 and TP4, proceed with Step 7. If waveform pulses are observed and measure near normal, proceed to Step 10.

7. Use the oscilloscope and observe the pen motor encoder output waveform. Measure the waveform at the Motherboard connector (A3A12J12, pins 2 and 3). Rotational direction noted below is defined as the motion applied to the shaft end of the pen motor.

A. Clockwise Rotation:



B. Counterclockwise Rotation:



Requirements:

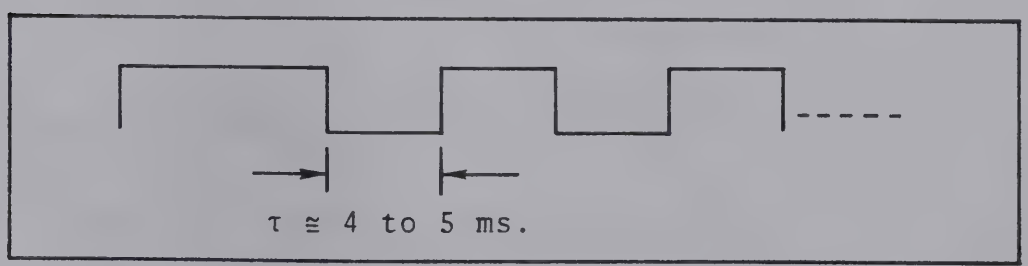
Observe that the pulse width is dependent on the speed of rotation. It is very important that the waveforms provide clean transitions and that the relative phasing is as shown in A and B according to the directional rotation.

If the waveforms are correct, proceed to Step 8. If the waveforms do not meet the Requirements, proceed to Step 9.

8. Previous tests have confirmed that the pen motor encoder provides adequate pulse waveforms but the pulses can not be observed at test points TP3 and TP4 on the Pen Control printed circuit board (A3A9). At this point, use the oscilloscope and the schematic diagram (Figure 7-42) to isolate the malfunction by tracing the pulses through the input buffers and multiphase circuits.

9. A normal conclusion after testing the system to this step is that the encoder on the pen motor is malfunctioning. Either troubleshoot the encoder or replace it with an assembly known to be good. After repair, verify operation by repeating Steps 1 through 8 as necessary.

10. If the Pen Control System continues to malfunction, use the oscilloscope to observe the steering waveform provided at test point TP2 on the Pen Control printed circuit board (A3A9). This waveform is generated by microprocessor control and is used to steer pulses to up/down counter groups. The pulse width will vary depending on which front panel pen function is selected. This is due to the program loop time required for the various pen functions. It should also be noted that every tenth pulse will vary in width. This is due to the program "reading" the front panel switch positions every tenth pass through the loop. A typical waveform is illustrated below:



The presence of this waveform strongly indicates proper operation of the CPU and Memory printed circuit boards.

Requirements:

a. If the waveform is not present but other tests indicate operation of the CPU and Memory printed circuit boards, proceed to Step 11.

b. If the waveform is observed to be normal, proceed to Step 12.

11. Check the address decoding at U9 on the Pen/Chart Servo Rate Loop printed circuit board (A3A11). (The address decoding for both the Pen System and Chart System are located on this printed circuit board.)

12. Use the oscilloscope to observe the up/down pulses provided to the Pen Control printed circuit board (A3A9). These pulses can be observed at U22-11 and U22-8 for Counter Group A, and/or U19-3 and U19-11 for Counter Group B. Note that the Steering function is controlled by the waveform at test point TP2 (used in Step 10).

Requirements:

a. If pulses are not present, proceed to Step 14.

b. If pulses are present, proceed to Step 13.

13. Use the oscilloscope to observe the operation of the up/down counters. Counter Group A (i.e., U1, U3, and U7) and Counter Group B (i.e., U4, U6, and U10) are alternately selected for count and read by the microprocessor. Observe for the generation of "carry" and "borrow" pulses at pins 12 and 13. Confirm that the Preset functions (PSET A and PSET B) occur. The counters are preset to mid-range to permit equal up-count and down-count ranges.

Preset functions (PSET A and PSET B) occur. The counters are preset to mid-range to permit equal up-count and down-count ranges.

14. Use the oscilloscope to observe the operation of the up/down steering gates U22 and U19. These gates should be enabled by counter steering flip-flop U16-6 and U16-8.

5.7 SECTION D: CHART SERVO CHECKOUT

5.7.1 The Series 1580 Pattern Recorder Chart Servo System consists of the Chart Control printed circuit board (A3A10), the Pen/Chart Servo Rate Loop printed circuit board (A3A11), the Chart Motor and Encoder (A1A1A2A1), and the Pen/Chart Servo Driver printed circuit board (A2A2). Troubleshooting procedures will attempt to isolate malfunctions to a general area by examination of the Chart Servo System response to signal commands and system responses.

NOTE

Remember that the Chart Control printed circuit board (A3A10) and the Pen Control printed circuit board (A3A9) are identical. When necessary, the two printed circuit boards can be interchanged for test purposes.

5.7.2 It can be noted that certain failures may be isolated by substitution, but actual malfunctions will be determined with conventional digital troubleshooting methods such as observing signal paths using the oscilloscope. The Chart Servo System Checkout procedures are illustrated in a flowchart form shown in Figure 5-5.

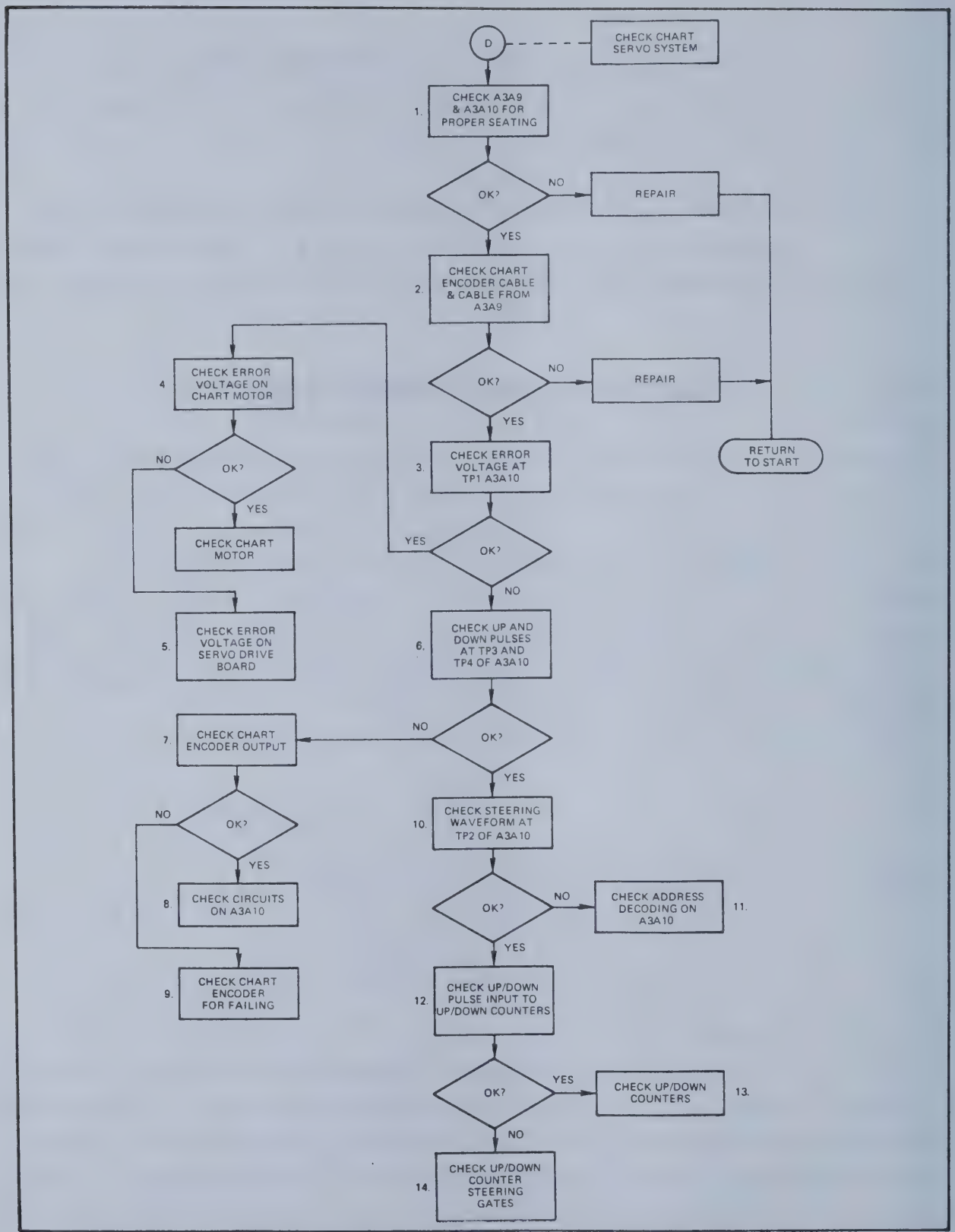


Figure 5-5. Chart Servo System Checkout Procedures, Maintenance Troubleshooting Flowchart 5

D. CHART SERVO SYSTEM CHECKOUT

1. Before applying ac power, carefully perform a visual inspection of all printed circuit boards, especially those associated with the Chart System (i.e., positions A3A10, A3A11, and A2A2) for proper seating, cable connectors secure and oriented correctly, etc.

2. Carefully check the chart encoder cable connector (A1A2P1) at the Motherboard (A3A12) to be secure and properly oriented. Similarly check the A2W3 cable connections at the Pen/Chart Servo Rate Loop printed circuit board (A3A11) and at the Pen/Chart Servo Driver printed circuit board (A2A2). If all connectors check to be adequate, then operate the front panel POWER ON-OFF switch to ON.

3. Check the error voltage at test point TP1 on the Chart Control printed circuit board (A3A10) with the digital voltmeter. Refer to the section on Adjustments for proper voltages and procedures.

   If the chart error voltage measured at test point TP1 is correct, proceed to Step 6. If the measured voltage is not correct, proceed with Step 4.

4. Measure the error voltage provided to the chart motor (A1A1A2A1). The error drive voltages are provided to the chart motor from the Pen/Chart Servo Driver printed circuit board (A2A2) and will vary between 0 volts (for no error) to ±23 volts (for maximum error).

Requirements:

a. Absence of drive voltage to the chart motor when error voltage is measured at TP1 indicates a possible malfunction on the Pen/Chart Servo Driver printed circuit board (A2A2). If chart motor error voltages are absent, proceed to Step 5.

b. If chart motor error voltages are present but the motor does not drive, the chart motor is suspect as the source of the malfunction.

5. Check error voltages on the Pen/Chart Servo Driver printed circuit board (A2A2).

Requirements:

a. If error voltages are absent on test points TP5 and TP6 when the pen is forced away from Null, proceed to Step 6.

b. If error voltages appear on test points TP5 and TP6, a possible area of malfunction is on the Pen/Chart Servo Driver printed circuit board (A2A2).

6. Use the oscilloscope and measure the up and down counter pulses provided between the test points TP3 and TP4 on the Chart Control printed circuit board (A3A10). A pulse width should measure approximately 300 nsec.

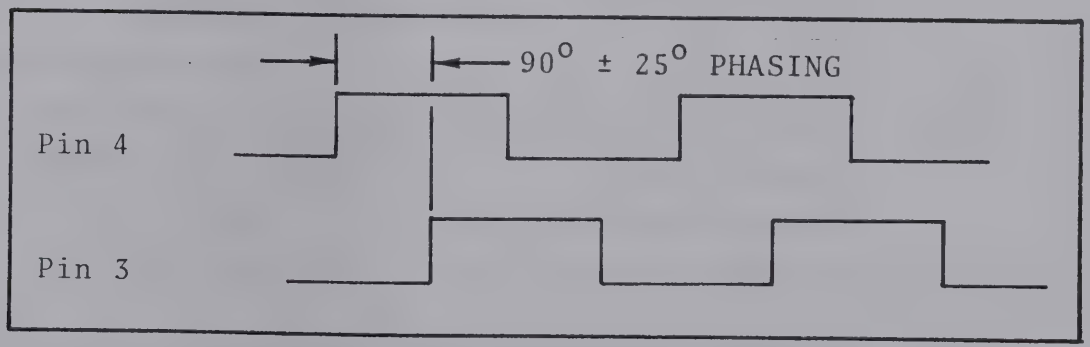
Requirements:

a. Pulse waveforms observed between test points TP3 and TP4 indicate the signal path conditions from the chart motor encoder through the input buffer and multiplier circuits provided on the Chart Control printed circuit board (A3A10). Extreme deviation in the waveform width indicates a possible malfunction in this signal path.

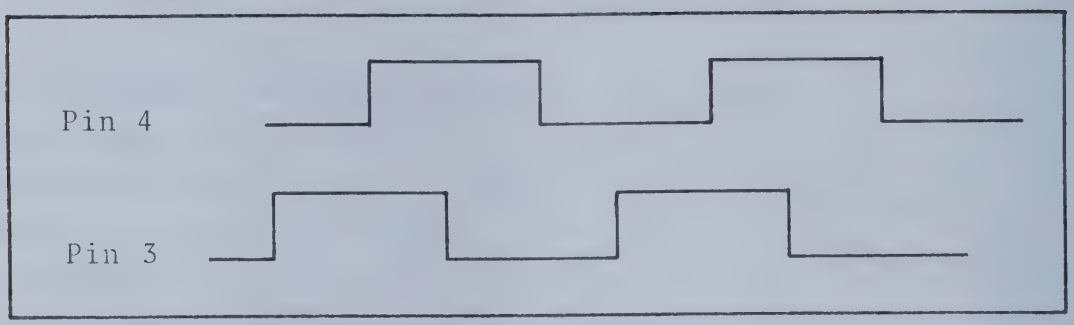
b. If waveform pulses do not appear at test points TP3 and TP4, proceed with Step 7. If waveform pulses are observed and measured near normal, proceed to Step 10.

7. Use the oscilloscope and observe the chart motor encoder output waveform. Measure the waveform at the Motherboard connector (A3A12J13, pins 3 and 4). Rotational direction noted below is defined as the motion applied to the shaft end of the chart motor.

A. Clockwise Rotation:



B. Counterclockwise Rotation:



Requirements:

Observe that the pulse width is dependent on the speed of rotation. It is very important that the waveforms provide clean transitions and that the relative phasing is as shown in A and B according to the directional rotation.

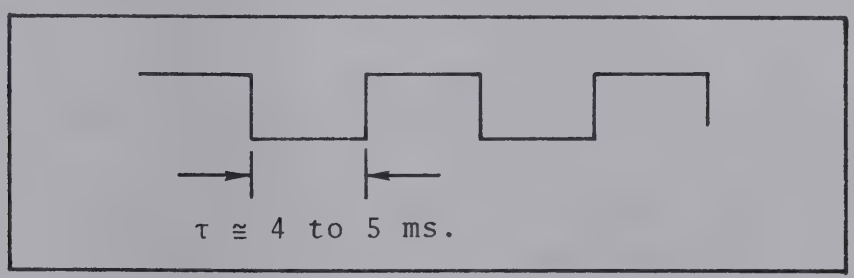
If the waveforms are correct, proceed to Step 8. If the waveforms do not meet the Requirements, proceed to Step 9.

8. Previous tests have confirmed that the chart motor encoder provides adequate pulse waveforms but the pulses can not be observed at test points TP3 and TP4 on the Chart Control printed circuit board (A3A10). At this point, use the oscilloscope and the schematic diagram (Figure 7-42) to isolate the malfunction by tracing the pulses through the input buffers and multiphase circuits.

9. A normal conclusion after testing the system to this step is that the encoder on the chart motor is malfunctioning. Either troubleshoot the encoder or

replace it with an assembly known to be good. After repair, verify operation by repeating Steps 1 through 8 as necessary.

10. If the Chart Control System continues to malfunction, use the oscilloscope to observe the steering waveform provided at test point TP2 on the Chart Control printed circuit board (A3A10). This waveform is generated by microprocessor control and is used to steer pulses to up/down counter groups. The pulse width will vary depending on which front panel chart function is selected. This is due to the program loop time required for the various chart functions. It should also be noted that every tenth pulse will vary in width. This is due to the program "reading" the front panel switch positions every tenth pass through the loop. A typical waveform is illustrated below:



The presence of this waveform strongly indicates proper operation of the CPU and Memory printed circuit boards.

Requirements:

a. If the waveform is not present but other tests indicate operation of the CPU and Memory printed circuit board, proceed to Step 11.

b. If the waveform is observed to be normal, proceed to Step 12.

11. Check the address decoding at U9 on the Pen/Chart Servo Rate Loop printed circuit board (A3A11). (The address decoding for both the Pen Servo System and Chart Servo System are located on this printed circuit board.)

12. Use the oscilloscope to observe the up/down pulses provided to the Chart Control printed circuit board (A3A10). These pulses can be observed at U22-11 and U22-8 for Counter Group A, and/or U19-3 and U19-11 for Counter Group B. Note that the Steering function is controlled by the waveform at test point TP2 (used in Step 10).

Requirements:

a. If pulses are not present, proceed to Step 14.

b. If pulses are present, proceed to Step 13.

13. Use the oscilloscope to observe the operation of the up/down counters. Counter Group A (i.e., U1, U3, and U7) and Counter Group B (i.e., U4, U6, and U10) are alternately selected for count and read by the microprocessor. Observe for the generation of "carry" and "borrow" pulses at pins 12 and 13. Confirm that the Preset functions (PSET A and PSET B) occur. The counters are preset to mid-range to permit equal up-count and down-count ranges.

14. Use the oscilloscope to observe the operation of the up/down steering gates U22 and U19. These gates should be enabled by counter steering flip-flots U16-6 and U16-8.

5.8 SECTION E: PEN SYSTEM DATA PATH

5.8.1 The Series 1580 Pattern Recorder Pen System Data Path troubleshooting is directed to correcting problems related to inaccurate pen position on the chart. Troubleshooting procedures will attempt to isolate malfunctions to a general area by examination of the Pen System which is proven operable but not accurate by a gross amount. Small pen inaccuracies are probably due to errors and problems described elsewhere in this chapter.

NOTE

Remember that the Pen Control printed circuit board (A3A9) and the Chart Control printed circuit board (A3A10) are identical. When necessary, the two printed circuit boards may be interchanged for test purposes.

5.8.2 It can be noted that certain failures may be isolated by substitution, but actual malfunctions will be determined with conventional digital troubleshooting methods such as observing signal paths with an oscilloscope. The Pen System Data Path troubleshooting procedures are illustrated in a flowchart form shown in Figure 5-6.

E. PEN SYSTEM DATA PATH

1. Before applying ac power, carefully perform a visual inspection of all printed circuit boards, especially those associated with the Pen System (i.e., positions A3A9, A3A11, and A2A2) for proper seating, cable connectors secure and oriented correctly, etc.

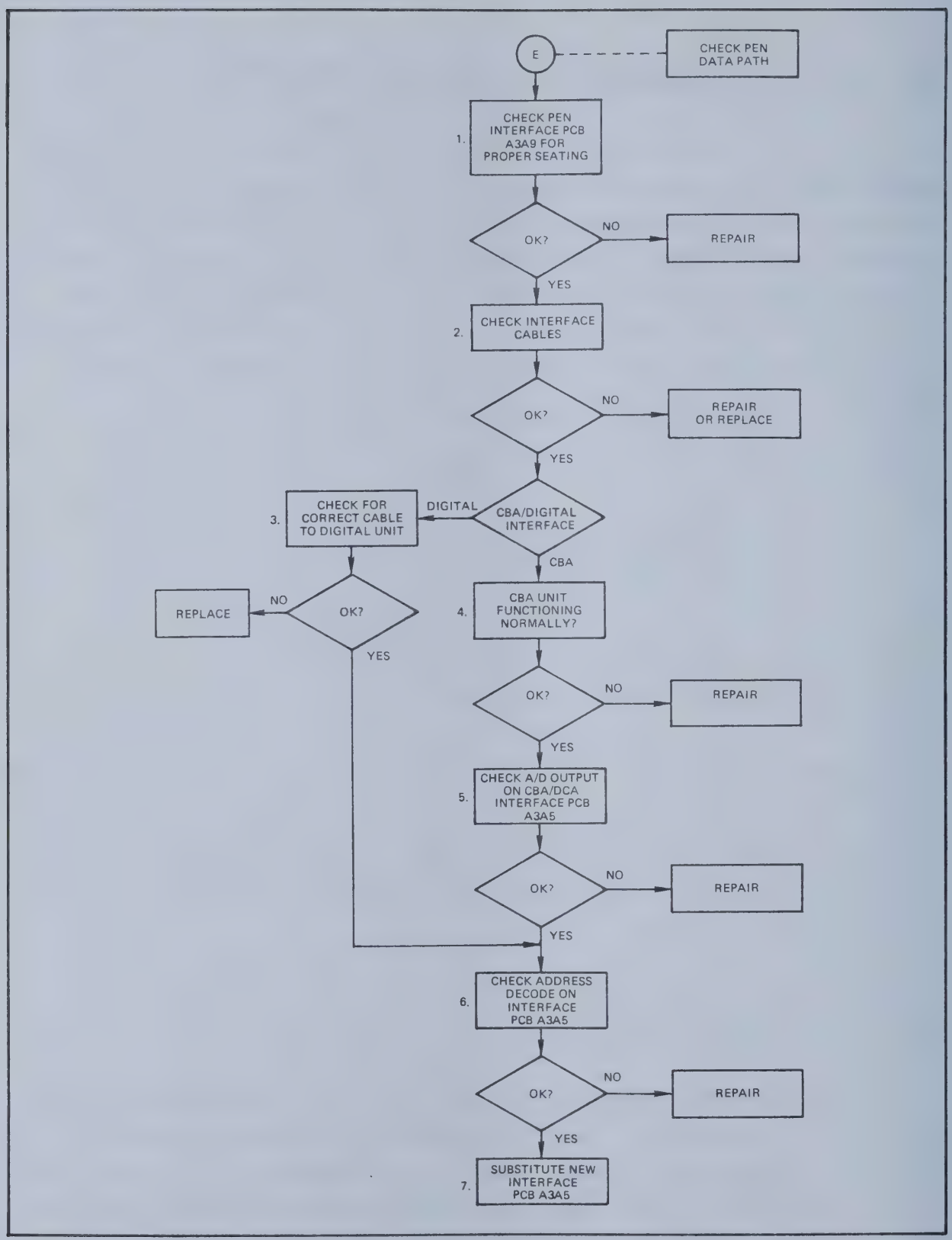


Figure 5-6. Pen System Data Path Troubleshooting Procedures, Maintenance Flowchart 6

2. Carefully check the pen encoder cable connector (A1A1A1P1) at the Motherboard (A3A12) to be secure and properly oriented. Similarly check the A2W3 cable connections at the Pen/Chart Servo Rate Loop printed circuit board (A3A11) and at the Pen/Chart Servo Driver printed circuit board (A2A2). If all connectors check to be adequate, then operate the front panel POWER ON-OFF switch to ON.

3. Determine the Pen System Data source input to be either from a CBA unit (i.e., a Model 1586 Crystal-Bolometer Amplifier) or a digital source (i.e., a Series 1833A Logarithmic Ratiometer). A digital type input will require a BCD interface to be used. For example, if a "byte" interface is provided by the input device, a "byte" interface cable must be used to interconnect with the Series 1580 Pattern Recorder. Check both the digital source signal format and interface cable against the following table to assure input compatibility.

INPUT DEVICE SIGNAL FORMAT	RECOMMENDED INTERFACE CABLE
Ratiometer: Parallel	162967
Ratiometer: Byte	162966
Phase Display: Parallel	162964
Phase Display: Byte	162965

4. If the Pen System Data source is provided from a CBA or DCA input, refer to the appropriate instruction manual to determine that the unit is functioning normally.

5. Check that a CBA/DCA Interface printed circuit board is used in the A3A5 position. Also check the A/D output signal generated by the CBA/DCA Interface printed circuit board.

6. If the input signals are initially tested to be processed correctly and a malfunction still exists, check the Address Decode function of the Interface printed circuit board used in A3A5 position.

7. If the malfunction is still prominent, the probable cause will be found on the Interface printed circuit board in the A3A5 slot. Replace the printed circuit board with one known to be good.

5.9 SECTION F: CHART SYSTEM DATA PATH

5.9.1 The Series 1580 Pattern Recorder Chart System Data Path troubleshooting is directed to correcting problems related to inaccurate chart position. Troubleshooting procedures will attempt to isolate malfunctions to a general area by examination of the Chart System which is proven operable but not accurate by a gross amount. Small chart inaccuracies are probably due to errors and problems described elsewhere in this chapter.

NOTE

Remember that the Chart Control printed circuit board (A3A10) and the Pen Control printed circuit board (A3A9) are identical. When necessary, the two printed circuit boards may be interchanged for test purposes.

5.9.2 It can be noted that certain failures may be isolated by substitution, but actual malfunctions will be determined with conventional digital troubleshooting methods such as observing signal paths with an oscilloscope. The Chart System Data Path troubleshooting procedures are illustrated in a flowchart form shown in Figure 5-7.

F. CHART SYSTEM DATA PATH

1. Before applying ac power, carefully perform a visual inspection of all printed circuit boards, especially those associated with the Chart System (i.e., positions A3A10, A3A11, and A2A2) for proper seating, cable connections secure and oriented correctly, etc.

2. Carefully check the chart encoder cable connector (A1A1A2P1) at the Motherboard (A3A12) to be secure and properly oriented. Similarly check the A2W3 cable connections at the Pen/Chart Servo Rate Loop printed circuit board (A3A11) and at the Pen/Chart Servo Driver printed circuit board (A2A2). If all connectors check to be adequate, then operate the front panel POWER ON-OFF switch to ON.

3. Determine the Chart System Data source input to be from either a synchro input (through the Synchro-to-Digital Transformer Assembly (A5) or a digital source (such as a Series 1840 Digital Synchro Display unit). A digital type input will require a BCD interface to be used. For example, if a "byte" interface is provided by the input device, a "byte" interface cable must be used to interconnect with the Series 1580 Pattern Recorder. Check both the digital source signal format and interface cable against the following table to assure input compatibility.

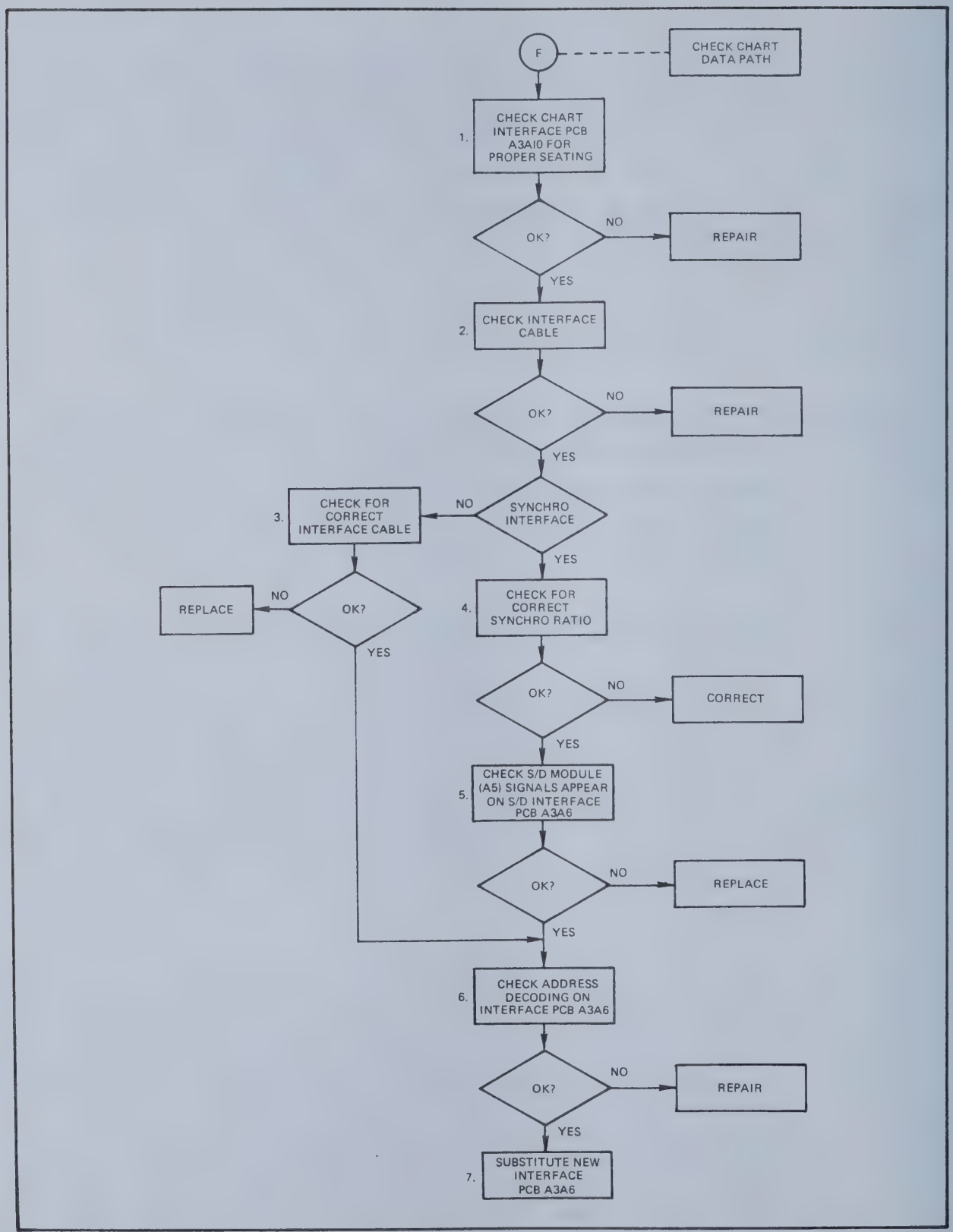


Figure 5-7. Chart System Data Path Troubleshooting Procedures, Maintenance Flowchart 7

INPUT DEVICE SIGNAL FORMAT	RECOMMENDED INTERFACE CABLE
Display: Parallel	162962
Display: Byte	162963

4. If the Chart System Data source is provided from a synchro unit, check for the proper synchro ratio through the S/D Transformer Assembly (A5) and proper conditioning and operation of the Model 1587 Synchro Selector Unit, if used.

5. Check that normal input signals from the S/D Transformer Assembly (A5) appear on the S/D Converter Assembly Interface printed circuit board (A3A6).

6. If the input signals are initially tested to be processed correctly and a malfunction still exists, check the Address Decode function of the S/D Converter Assembly Interface printed circuit board (A3A6).

7. If the malfunction is still prominent, the probable cause will be found on the S/D Converter Assembly Interface printed circuit board in the A3A6 slot. Replace the printed circuit board with one known to be good.

5.10 SECTION G: MISCELLANEOUS PROBLEMS

5.10.1 This section is dedicated to miscellaneous problems that affect the electro-mechanical functions of a Series 1580 Pattern Recorder. When operational malfunctions defy normal troubleshooting techniques and the cause and remedy are found by the engineering staff, the checkout/quality assurance department,

or by field technicians, the information and procedures will be incorporated into this section first by Instruction Manual Update sheets and then incorporated into text through future reprinting of this manual.

5.10.2 All personnel associated with the operation and maintenance of the Series 1580 Pattern Recorder, or other Scientific-Atlanta products, are invited to send comments about field related problems and maintenance tips to Scientific-Atlanta, Customer Service and/or Instrumentation Publications, 3845 Pleasantdale Road, Atlanta, Georgia 30340.

1. Pen Lift Solenoid
2. Paper Sensor
3. Pen Calibrate Problems

1. Pen Lift Solenoid. If the pen lift solenoid becomes operationally erratic or fails to operate at all, check the following possible causes:

   a. A lower than normal drive voltage applied to the solid state relay which drives the pen solenoid.
   b. Test for an ac voltage on the output of the solid state relay.
   c. Check for possible mechanical binding on the pen lift assembly.

2. Paper Sensor. The functions of the paper sensor is to (1) detect the edge of the chart paper and (2) prevent the unwanted rewinding of paper onto the supply roll. Erratic operation or complete failure may stem from the following causes:

a. Check that an electrical output from the paper sensor is provided to the Pen Calibrate printed circuit board assembly (A1A2).
b. Check the mechanical alignment of the paper sensor assembly.

3. Pen Calibrate Problems. If obtaining accurate pen calibration becomes a problem, the following possible causes should be considered. Remember that these causes are offered with the presumption that other recorder functions are normal, the microprocessor is operating, and the pen servo system is functional. The absence of pen calibration could be caused by problems on the Pen Calibrate printed circuit board assembly (A1A2). Check the following possible causes:

a. Thoroughly check cable connections between the front panel controls and the Panel Control Interface printed circuit board.
b. If the pen will not drive to the bottom of the chart, check the operation of switch S3 on the Pen Calibrate printed circuit board assembly (A1A2).
c. If pen adjustments do not respond to the Pen Calibrate position, thoroughly check the operation of switches S1 and S2 on the Pen Calibrate printed circuit board assembly (A3A1).

5.11 ADJUSTMENTS AND CALIBRATION

5.11.1 The instructions provided in this section permit field adjustments and calibration levels to be performed when necessary. When calibration levels are out of tolerance or dif-

ficult to achieve, this could be an indication of other malfunctions which should be corrected prior to returning the equipment to service.

5.11.2 Each group of adjustment and calibration procedures are independant and can be performed in any sequence as desired. This section will be expanded in future printings of the manual to provide more diagnostic maintenance and field service information for the Series 1580 Pattern Recorder and associated equipments.

A.PEN/CHART CONTROL ADJUSTMENTS

5.11.3 The Pen/Chart Control Adjustments permit equal positive and negative drive voltages for the Pen and Chart Servo Systems.

1. Operate the Series 1580 Pattern Recorder front panel POWER-ON switch to the ON position.

2. Allow sufficient time for all power-up initialization to take place.

3. Pen Adjustment

    a. Connect a digital voltmeter between test point TP1 and common on the Pen Control printed circuit board (A3A9).
    b. Inject a signal into the Series 1580 Pattern Recorder pen input which will cause the pen to be approximately at mid-scale.
    c. Open the recorder Head Assembly to gain access to the pen drive pulley.

d. Gently force the error voltage away from 0 volts by hand. This is accomplished by physically forcing the pen drive pulley away from the servo null.
e. Observe the digital voltmeter indication while forcing the pen drive pulley.
f. Forcing the pen drive pulley counterclockwise should produce approximately -4.0 volts.
g. If necessary, adjust variable resistor A3A9R13 until the observed voltage indications are equal in magnitude to within ±0.1 volt.
h. With the pen nulled at midscale, adjust A2A2R3 (located on A2A2 PWB in Power Supply) for 0 volts (±.01V).

4. Chart Adjustment

a. Connect a digital voltmeter between test point TP1 and common on the Chart Control printed circuit board (A3A10).
b. Gently force the error voltage away from 0 volts by hand. This is accomplished by physically forcing the chart drum away from the servo null.
c. Observe the digital voltmeter indication while forcing the chart drum. Forcing the chart drum forward (paper out direction) should produce approximately +2.0 volts.
d. Forcing the chart drum in reverse (paper in direction) should produce approximately -2.0 volts.
e. If necessary, adjust variable resistor A3A10R13 until the observed voltage indications are equal in magnitude to within ±0.1 volt.
f. With the chart nulled, adjust A2A2R27 (located on A2A2 PWB in Power Supply) for 0 volts (±.01V).

5. This is the end of the Pen/Chart Adjustments.

B. PEN CALIBRATION

5.11.4 Pen calibration permits the proper placement of the recorder pen carriage on the pen drive string and the adjustments necessary to obtain accurate full scale pen travel. The adjustments correct for dimensional instabilities of the chart paper are usually caused by humidity and temperature.

1. If necessary, operate the Series 1580 Pattern Recorder front panel POWER-ON switch to the OFF position.

2. If necessary, install any chart paper designed for the Series 1580 Pattern Recorder.

3. Operate the front panel PEN LIFT switch to OFF.

4. Open the recorder Head Assembly for access to the small Pen Calibrate Assembly printed circuit board (A1A2). Operate switch S3 to the OFF position.

5. Operate the front panel POWER-ON switch to the ON position.

6. When ac power is applied, the pen unit will be driven slowly to the right side of the recorder chart paper. The pen unit will travel to a physical stop, then move slightly to the left of this position and stop again. This second stop should correspond with the top-most printed line on the chart paper.

7. If necessary, loosen the two screws which clamp the pen carriage to the pen drive cable. Gently adjust the pen carriage without moving the pen cable until the

pen point is directly over the top printed chart paper line. Secure the pen carriage to the pen drive cable by tightening the two screws of the pen carriage clamp.

8. If necessary, open the recorder Head Assembly. Operate the Pen Calibrate Assembly printed circuit board (A1A2) switch S3 to the ON position.

9. Observe that the pen will deflect to the extreme left side of the chart and should be positioned over the bottom-most printed line on the chart paper.

10. Alternately adjust between switches S1 and S2 on the Pen Calibrate Assembly printed circuit board (A1A2) until the pen point is directly centered on the bottom-most printed line on the chart paper. Switches S1 and S2 are both digital BCD output switches, each with screwdriver slot adjustment. Switch S1 provides the coarse adjustment and switch S2 provides the fine adjustment to the pen position.

11. Operate the Pen Calibrate Assembly printed circuit board (A1A2) switch S3 to the OFF position. Close the recorder Head Assembly. Operate the PEN LIFT switch to LIFT or WRITE. The Series 1580 Pattern Recorder is ready for manual operation.

12. This is the end of the Pen Calibration Procedure.

C. OPTION SELECTION

5.11.5 When an option (or options) is added to the Series 1580 Pattern Recorder, the necessary optional printed circuit board must be connected into the Data Processor Assembly (A3).

It will also be necessary to readjust the DIP (dual in-line pin) rocker switches provided by U16 on the Control Panel printed circuit board (A3A1).

1. If necessary, operate the Series 1580 Pattern Recorder front panel POWER-ON switch to the OFF position.

2. Remove the Data Processor Assembly (A3) card retainer and safety cover. Install the desired option printed circuit board(s) in the correct positions. Be sure the component side is properly oriented.

3. Carefully disconnect the flat cable connectors from the Control Panel printed circuit board (A3A1) and remove it from the motherboard connector.

4. Locate the DIP switch component U16. Properly position the eight rocker switches according to the following list. Each rocker switch must be in the ON position to able an option.

OPTION SELECTION

SWITCH POSITION	OPTION SELECTION
1	Optional Memory (A3A4). The Optional Memory printed circuit board (A3A4) is required for both the POLAR and the IEEE-488 option. The switch position must be ON to use the Optional Memory printed circuit board (A3A4).
2	Spare
3	CBA/DCA Interface (A3A5). The switch position must be ON to use the CBA/DCA Interface printed circuit board (A3A5).

SWITCH POSITION	OPTION SELECTION
4	Digital Interface (A3A5) for Pen Function. The switch position must be ON to use a digital input to the pen servo system from equipment such as a Series 1833A Logarithmic Ratiometer or a Model 1822 Digital Phase Display.
5	Digital Interface (A3A6) for Chart Function. The switch position must be ON to use a digital input to the chart servo system from equipment such as the Series 1842/43 Digital Synchro Display equipment.
6	Synchro-to-Digital (S/D) Converter (A3A6). The switch position must be ON to use the S/D Converter printed circuit board (A3A6) and the 1:1 or 36:1 analog synchro signals through the S/D Transformer Assembly (A5).
7	60 dB Option (A3A8). The switch position must be ON to use the 60 dB Option printed circuit board (A3A8).
8	IEEE-488 Interface Option (A3A7). The switch position must be ON to use the IEEE-488 Interface Option printed circuit board (A3A7).

5. Return the Control Panel printed circuit board (A3A1) to the original position. Observe that the component side is properly oriented. CAREFULLY replace the flat ribbon cable connectors. It is very easy to bend connector pins and/or misalign the connection, which in turn, causes apparent malfunctions elsewhere.

6. This is the end of the Option Selection procedures.

D.60 dB OPTION CALIBRATION

5.11.6 The 60 dB Option is provided for use with a Scientific-Atlanta Model 1711 Microwave Receiver. The proper use of this feature is provided in other sections of this manual.

1. If necessary, operate the Series 1580 Pattern Recorder front panel POWER-ON switch to the OFF position.

2. Install the 60 dB Option printed circuit board (A3A8) in the proper location of the Data Processor Assembly (A3). (If necessary, refer to the steps given in C. OPTION SELECTION PROCEDURES.)

3. Connect a coaxial cable from connector J4 on the Digital Interface Panel Assembly (A6) to the 60 dB feedback input connector on the Model 1711 Microwave Receiver rear panel.

4. If necessary, reload the Series 1580 Pattern Recorder chart paper with a roll of 60 dB chart paper.

5. Apply ac power to both the receiver and the Series 1580 Pattern Recorder. Allow sufficient warm-up time for the receiver and the recorder initialization.

6. Calibrate the Series 1580 Pattern Recorder pen servo system as directed in B. PEN CALIBRATION.

7. Properly position the Series 1580 Pattern Recorder front panel switches as follows:

   a. Pen function to LOG
   b. Pen scale to 80/40 dB
   c. Set PEN to WRITE

8. Using the signal input from the Model 1711 Microwave Receiver, adjust the signal level from the receiver to cause the recorder pen to be at 0 dB on the 60 dB chart paper.

9. Connect a digital voltmeter to test point TP1 and common on the 60 dB Option printed circuit board (A3A8). If necessary, adjust variable resistor A3A8R4 so the digital voltmeter indicates 0.0 volts.

10. Insert a step attenuator (or equivalent circuit) in series with the input signal applied to the Model 1711 Microwave Receiver. Reduce the input signal level by 60 dB.

11. Observe that the digital voltmeter, connected as in Step 9, indicates 6.0 volts. If necessary, adjust variable resistor A3A8R8 until the 6.0 volt indication is obtained.

12. Observe that the Series 1580 Pattern Recorder pen has moved to the -60 dB mark on the 60 dB chart paper.

13. Repeat Steps 7 through 10 until no further adjustments are necessary.

14. This is the end of the 60 dB Option Calibration.

E. PAPER SENSOR ADJUSTMENTS

5.11.7 Paper Bottom Sensor Assembly (A1A5). The Paper Bottom Sensor Assembly provides a solid state infrared light source transmitter and a similar optical receiver mounted on a bracket in the Head Assembly (A1). Figure 5-8 shows the location of this assembly. Both transmitter and receiver are mounted on a printed

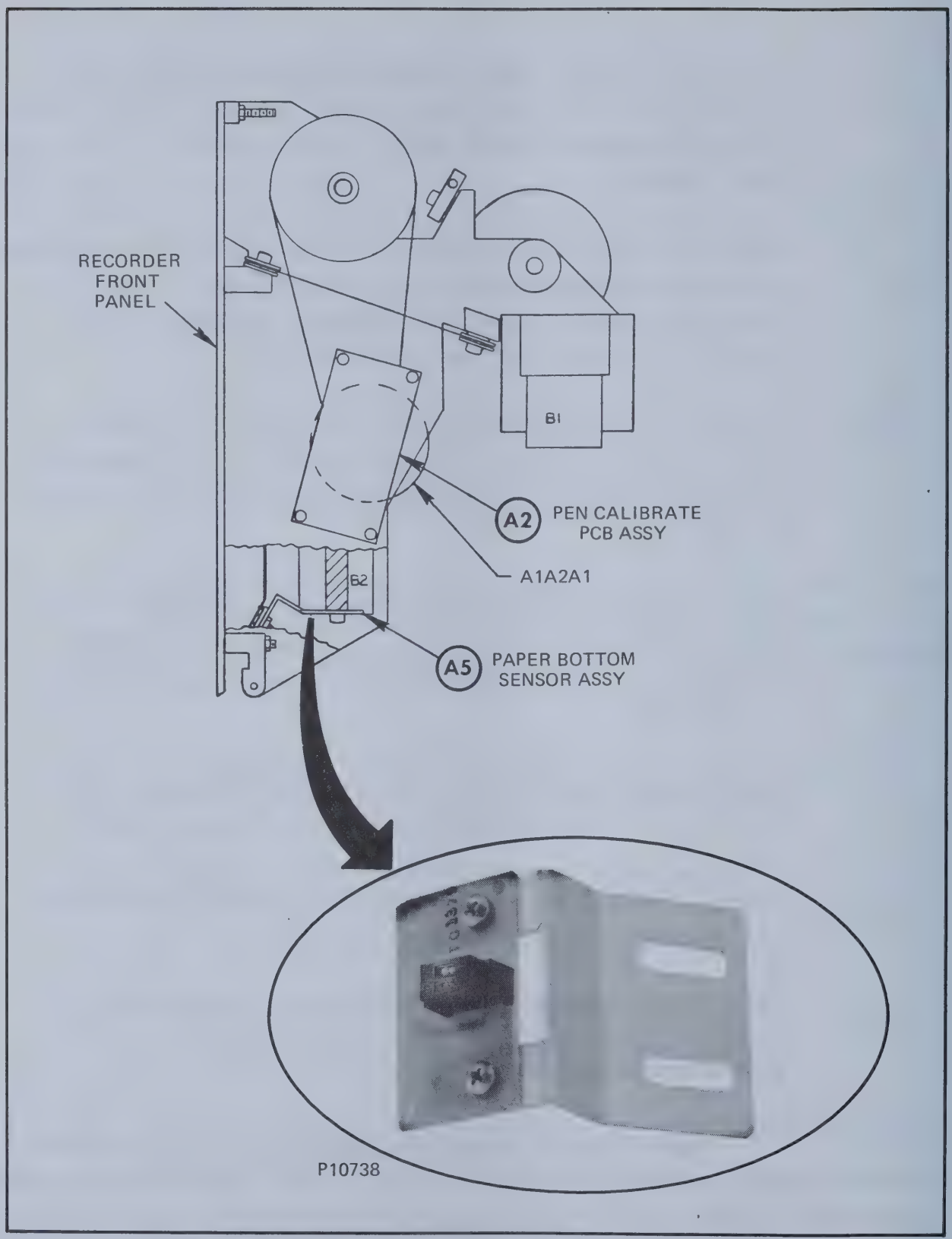


Figure 5-8. Paper Sensor Components and Locations

circuit board and bracket which is secured in place with two Phillip's head screws. When adjustment is required, loosen the two screws securing the bracket to the Head Assembly (A1). (Note: This requires either a very short #2 screwdriver or a #2 offset screwdriver because of limited access.) Move the complete assembly until the light source transmitter/receiver is centered in the hole punched for its use. Centering the unit can be observed using the reflective surfaces in the chart paper path. After centering the assembly, tighten the mounting screws securely. To check that this adjustment is acceptable, thread a roll of chart paper on the equipment as for normal operation. Allow the leading paper edge to trail out approximately 12 to 18 inches. With front panel controls and switches set to simulate normal operation and with no signal input, shake the loose paper end vigorously in all possible directions and observe the chart paper on the writing area remains stationary.

5.12 REGIONAL SERVICE CENTERS

5.12.1 Regional Service Centers capable of performing periodic maintenance and providing assistance associated with Scientific-Atlanta Instrumentation equipment are listed below. Service Assistance for areas not listed can be provided through the Scientific-Atlanta Field Service Center, 4025 Pleasantdale Road, Atlanta, Georgia 30340; TEL: 404-449-2184; TWX: 810-766-4912; TELEX: 0542898.

DOMESTIC REGIONAL SERVICE CENTERS

Northeastern Regional Office
149 Middlesex Turnpike
Burlington, Massachusetts 01803
Tel: 617-272-1256

Washington D.C. Regional Office
Washington Business Park
5100-J Philadelphia Way
Tanham, Maryland 20706
Tel: 301-577-4830

Mid Atlantic Regional Office
2100 Route 208
Fair Lawn, New Jersey 07410
Tel: 201-791-8777

Southeastern Regional Office
4025 Pleasantdale Road
Atlanta, Georgia 30340
Tel: 404-449-2021

Florida Regional Office
P.O. Box 2143
841 West Emmett St.
Kissimmee, Florida 32741
Tel: 305-846-0055

Midwest Regional Office
Fidelity Bldg., Suite 306
11550 N. Meridian
Carmel, Indiana 46032
Tel: 317-846-7142

Southwestern Regional Office
1237 Executive Drive, East
Richardson, Texas 75081
Tel: 214-238-1116

So. California Regional Office
P.O. Box 2668
10039 Pioneer Boulevard
Santa Fe Springs, California 90670
Tel: 213-949-9411

No. California Regional Office
3375 Scott Boulevard, Suite 304
Santa Clara, California 95051
Tel: 408-496-1040

INTERNATIONAL SERVICE CENTERS

CANADA
Scientific-Atlanta, Ltd.
1640 Bonhill Road
Unit 6
Mississauga, Ontario L5T1C8
Tel: 416-677-6555
Telex: 06983600

ENGLAND
Scientific-Atlanta, Ltd.
Horton Manor
Stanwell Road, Horton
Slough SL3 9PA, England
Tel: 44.2812-3211
Telex: 849406

FRANCE
Scientific-Atlanta S.A.
4 Avenue Gabriel Peri
78360 Montesson
France
Tel: 33.1.9769191
Telex: #46385

GERMANY
Scientific-Atlanta GmbH
Albert Schweitzerstrasse 66/3
D8000 Munich 83, Germany
Tel: 49.8967.1044
Telex: 5212264

ITALY
Scientific-Atlanta, S.p.A.
Via Benedetto Croce 19
00142 Rome, Italy
Tel: 39.06.5420244
Telex: 721441

CHAPTER 6
PARTS LISTS

6.1 GENERAL

6.1.1 The parts lists for a Series 1580 Pattern Recorder are included in this chapter. Special modifications, if any, are enclosed in the envelope in the rear of this manual.

6.2 EXPLANATION OF COLUMN HEADINGS

6.2.1 REF. DESIG. This identifies the assigned reference designation applicable to a system or equipment sub-unit having a separate prefix and arrangement of individual components.

6.2.2 COMP. DESIG. This identifies the components of the sub-unit in alpha-numerical order.

6.2.3 SCIENTIFIC-ATLANTA (S-A) PART NO. A five or six digit number assigned by the manufacturer to the specific part for identification and correct replacement ordering information.

6.2.4 DESCRIPTION. A brief electrical and/or mechanical description of the component.

6.2.5 FSCM. The proper Federal Supply Code for manufacturers is entered in this column. The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) in effect as of the publication date of this manual. Alphabetical codes have been

arbitrarily assigned to suppliers not assigned in the H4 handbooks and these identifying codes are cross-referenced (code to name) at the end of this section.

6.2.6 MFR. PART NO. The number assigned to a part by an outside supplying manufacturer is listed in this column.

6.3 ORDERING PARTS

6.3.1 When ordering parts from Scientific-Atlanta, always include the Scientific-Atlanta part number, the part description, the unit name, the unit serial number, the subassembly name, the part manufacturer (FSCM), and the manufacturer's part number.

6.4 PARTS SUBSTITUTION

6.4.1 Common components may differ from those identified in the parts list. This difference is due to the substitution of a more current part during assembly. When this occurs, the replacement may be either a part identical to the type removed or a part meeting the description given in the parts list.

INDEX

REF DESIG	Part No.	Title	Page
	163106	Recorder Assembly	6-4
A1	164722	Head Assembly	6-5
A1A1	160809	Head Sub-Assembly	6-6
A1A1A1	160808	Frame Assembly	6-7
A1A1A1A1	164723	Pen Motor & Encoder Assembly	6-8
A1A1A2	160807	Right Side Frame Assembly	6-9
A1A1A2A1	164724	Chart Motor & Encoder Assembly	6-10
A1A2	158388	Pen Calibrate PWB Assembly	6-11
A1A3	163041	Pen Control Panel Assembly	6-12
A1A4	163040	Chart Control Panel Assembly	6-13
A1A5	163103	Bottom Paper Sensor PWB Assembly	6-14
A2	163037	Power Supply Assembly	6-15
A2A1	158327	Regulator PWB Assembly	6-17
A2A2	219157	Chart & Pen Servo PWB Assembly	6-19
A3	158351	Data Processor Assembly	6-21
A3A1	151488	Control Panel Interface PWB Assembly	6-22
A3A2	156088	CPU PWB Assembly	6-23
A3A3	256211	Memory 1 PWB Assembly	6-24
A3A4	256213	Memory 2 PWB Assembly	6-25
A3A5	158391	CBA/DCA Interface PWB Assembly	6-26
A3A5	158455	Digital Interface PWB Assembly	6-27
A3A6	151489	Synchro to Digital Converter PWB Assembly	6-28
A3A6	158455	Digital Interface PWB Assembly	6-29
A3A7	252588	IEEE-488 Interface PWB Assembly	6-30
A3A8	158501	60 dB Interface PWB Assembly	6-31
A3A9	158452	Pen/Chart Control PWB Assembly	6-32
A3A10	158452	Pen/Chart Control PWB Assembly	6-34
A3A11	162915	Servo Rate Loop PWB Assembly	6-36
A3A12	158363	Motherboard PWB Assembly	6-38
A5	163072	S/D Transformer Module Assembly	6-39
A5A1	158383	S/D Module PWB Assembly	6-40
A6	162121	Digital Interface Panel Assembly	6-41
		FSCM Manufacturer Cross Reference	6-42

SERIES 1580 PATTERN RECORDER ASSY-163106

REF DESIG PREFIX 01

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A 001	0164722	HEAD ASSY		
A 002	0163037	POWER SUPPLY ASSY		
A 003	0158351	DATA PROCESSOR ASSY		
A 004	0164738	CHASSIS ASSY		
A 005	0163072	S/D TRANSFORMER MODULE ASSY		
A 006	0162121	DIGITAL INTERFACE PANEL ASSY		
W 001	0218912	CABLE ASSY PEN CALIBRATE		
W 002	0217644	CABLE ASSY CHART CONTROL (1)		
W 003	0217645	CABLE ASSY CHART CONTROL (2)		
W 004	0217646	CABLE ASSY PEN CONTROL		

HEAD ASSEMBLY-164722

REF DESIG PREFIX A1

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A1	160809	HEAD SUB-ASSY		
A2	158388	PWB ASSY PEN CALIBRATE		
A3	163041	PANEL ASSY PEN CONTROL		
A4	163040	PANEL ASSY CHART CONTROL		
A5	163103	PWB ASSY SENSOR PAPER BOTTOM		
K1	87071	RELAY SOLID STATE SPST 140V 8A CONTACTS	W2QX-1	
W1	163104	CABLE ASSY		
W2	163105	CABLE ASSY		

HEAD SUB-ASSY-160809

REF DESIG PREFIX A1A1

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A1	160808	FRAME ASSY - LEFT SIDE		
12	86359	CHAIN MIN-E-PITCH .15708 PITCH ENDLESS		3CCF-84-E
13	218562	GUIDE PAPER		
15	160769	PLATEN RECORDER		
20	160741	CAM-PEN LIFT		
21	156839	ROD PEN LIFT		
22	162032	CARRIAGE ASSY-PEN		
23	162030	CLAMP CABLE PEN		
30	164755	ACTUATOR SWITCH		
31	72889	SWITCH MICRO SPDT-T-TERMINAL	91929	11SM1T
5	154891	SPROCKET CHART DRIVE		
7	160806	ARM ASSY - PAPER TENSION		
9	164709	CABLE-PEN DRIVE		

1580

LEFT SIDE FRAME ASSEMBLY-160808

REF DESIG PREFIX A1A1A1

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO-----
A1	164723	MOTOR AND ENCODER ASSY -PEN		
10	14386	PULLEY ASSY PEN CABLE	10110	14386
11	72854	SOLENOID	82768	41C 115 60AX
12	162068	STOP SOLENOID		
13	156840	HUB - CHART ROLL		

1580

PEN MOTOR & ENCODER ASSY-164723

REF DESIG PREFIX A1A1A1A1

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO-----
1	156732	MOTOR SERVO		
2	86518	ENCODER DUAL SQ WAVE 1200 PULSES PER REV		992-1200-D-C-L-S

1580

RIGHT SIDE FRAME ASSEMBLY-160807

REF DESIG PREFIX A1A1A2

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO---
A1	164724	MOTOR AND ENCODER ASSY-CHART		
11	160810	HUB AND GEAR ASSY - CHART TAKE-UP		
15	164699	MOTOR CHART REWIND		
19	14386	PULLEY ASSY PEN CABLE	10110	14386
21	218775	STUD ECCENTRIC - GUIDE SPROCKET		
5	86427	MOTOR AC .0015HP 2200RPM SHADED POLE		DYAA 721-118
6	156842	WHEEL MOTOR		
9	156841	SPROCKET GUIDE		

1580

CHART MOTOR & ENCODER ASSY-164724

REF DESIG PREFIX A1A1A2A1

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
1	156732	MOTOR SERVO		
2	86517	ENCODER DUAL SQ WAVE 500 PULSES PER REV		992-500-J-C-L-S

PEN CALIBRATE PWB ASSY-158388

REF DESIG PREFIX A1A2

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C1	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
J1	86648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
Q1	77147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q2	77147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
R1	71913	RESISTOR 270 OHM 1/4W 10% COMP	01121	RCR07G271KS
R2	71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R3		NOT ASSIGNED		
R4	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R5	71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R6	71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R7	71989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R8	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R9	71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
S1	87122	SWITCH 1P BINARY 10 POS DIP PC MT		2300026
S2	87122	SWITCH 1P BINARY 10 POS DIP PC MT		2300026
S3	86957	SWITCH SLIDE SPDT PC MT		24-220-020

PEN CONTROL PANEL ASSY-163041

REF DESIG PREFIX A143

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
CR1	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR2	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR3	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR4	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR5	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR6	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR7	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
J1	84530	SOCKET 16 PIN DIP PC MT	91506	516-AG11D
S1	86969	SWITCH PUSHB SPDT MOM		8121-J31-C-6-2
S2	86967	SWITCH LEVER SPST CNTR OFF GRN LEVER		7103-J61-C-0-6-2
S3	86969	SWITCH PUSHB SPDT MOM		8121-J31-C-6-2
S4	86967	SWITCH LEVER SPST CNTR OFF GRN LEVER		7103-J61-C-0-6-2
S5	87375	SWITCH TOG DPDT AC 10A 250V FLAT TOG		7505K65C
5	218447	SHIELD AC POWER SWITCH		
6	132439	DECAL HIGH VOLTAGE 1/2-IN.X 1-IN.		PER SA DWG 132439
7				

CHART CONTROL PANEL ASSY-163040

REF DESIG PREFIX A1A4

COMP DESIG	S-A PART NO.	DESCRIPTION	FSCM	MFR PART NO.
CR1	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR2	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR3	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR4	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR5	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
CR6	87070	LAMP LED RED .125 DIA .200 LNG 3.0V 40MA		TIL209A
J1	84530	SOCKET 16 PIN DIP PC MT	91506	516-AG11D
J2	84530	SOCKET 16 PIN DIP PC MT	91506	516-AG11D
S1	86969	SWITCH PUSHB SPDT MOM		8121-J81-C-6-2
S2	86967	SWITCH LEVER SPST CNTR OFF GRN LEVER		7103-J61-C-Q-6-2
S3	86968	SWITCH LEVER SPDT MOM-CNTR OFF GRN LEVER		7105-J61-C-Q-6-2
S4	86968	SWITCH LEVER SPDT MOM-CNTR OFF GRN LEVER		7105-J61-C-Q-6-2
S5	86967	SWITCH LEVER SPST CNTR OFF GRN LEVER		7103-J61-C-Q-6-2
S6	86968	SWITCH LEVER SPDT MOM-CNTR OFF GRN LEVER		7105-J61-C-Q-6-2
S7	86968	SWITCH LEVER SPDT MOM-CNTR OFF GRN LEVER		7105-J61-C-Q-6-2
S8	86967	SWITCH LEVER SPST CNTR OFF GRN LEVER		7103-J61-C-Q-6-2

1580

BOTTOM PAPER SENSOR PWB ASSY-163103

REF DESIG PREFIX A1A5

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
K1	87071	RELAY SOLID STATE SPST 140V 8A CONTACTS		W2QX-1
(1) U1	87069	OPTO-ISOLATOR REFLECTIVE OBJECT SENSOR		MCA7
U1	170277	OPTICAL SWITCH REFLECTIVE SENSOR		SPX 1397-31
W1	163104	CABLE ASSY		
W2	163105	CABLE ASSY		

(1) U1 PART NUMBER MAY VARY WITH EACH UNIT.

POWER SUPPLY ASSEMBLY-163037

REF DESIG PREFIX A2

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A 001	0158327	PWB ASSY REGULATOR		
A 002	0219157	PWB ASSY CHART AND PEN SERVO		
B 001	0074200	FAN 4 1/2 IN BOXER	99743	WS2107F
C 001	0077245	CAPACITR 3000 MF 30V	80183	39D308G030JS4
C 002	0077245	CAPACITR 3000 MF 30V	80183	39D308G030JS4
C 003	0080883	CAPACITR 18000 MF 25V		36D183G025BC2A
C 004	0083210	CAPACITR 11000 MF 50V	53021	500113U050BC2B
C 005	0083210	CAPACITR 11000 MF 50V	53021	500113U050BC2B
C 006	0079751	CAPACITR .33 MF 200V POLYCARB 5%	24152	17UC334J
C 007	0079751	CAPACITR .33 MF 200V POLYCARB 5%	24152	17UC334J
C 008	0075217	CAPACITR 10 MF 50V	80183	500D106G050CB7
C 009	0075217	CAPACITR 10 MF 50V	80183	500D106G050CB7
C 010	0075219	CAPACITR 100 MF 50V	80183	500D107G050DH7
C 011	0075219	CAPACITR 100 MF 50V	80183	500D107G050DH7
CR001	0084825	RECTIFIER ASSY 600V 6A SOLDER TERMINALS	83003	VH648TT
CR002	0086964	RECTIFIER ASSY 600V 35A		MDA-3506BYW66
CR003	0086964	RECTIFIER ASSY 600V 35A		MDA-3506BYW66
CR004	0081050	DIODE MR751 SIL 100V 6A	04713	MR751
CR005	0081050	DIODE MR751 SIL 100V 6A	04713	MR751
JFL1	0083759	CONN AC MALE 3-COND 3A W/FUSE BLK & FILT		6J4
JFX	0085373	CONN AC LINE V SELCTR-REPLCMNT-FOR 83759		70-1470
Q 001	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 002	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 003	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 004	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 005	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 008	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 009	0086962	TRANSSTR MJ11016 NPN SIL POWER TO-3		MJ11016
Q 010	0086961	TRANSSTR MJ11015 PNP SIL POWER TO-3		MJ11015
Q 011	0086962	TRANSSTR MJ11016 NPN SIL POWER TO-3		MJ11016
R 001	0071984	RESISTOR 2,7K OHM 1W 10% COMP	01121	RCR32G272KS
R 002	0083570	RESISTOR 1,5 OHM 3W WW 5%	24681	VAL-3
R 003	0077146	RESISTOR .5 OHM 5W 5%	15915	TS5W-6706
R 004	0077146	RESISTOR .5 OHM 5W 5%	15915	TS5W-6706
R 005	0071816	RESISTOR 1 OHM 5W WW 5%	24681	VAL5
R 006	0071816	RESISTOR 1 OHM 5W WW 5%	24681	VAL5
R 007	0084979	RESISTOR .75 OHM 5W WW 5%	44655	225-8-R7500J
R 008	0072004	RESISTOR 4,7K OHM 1W 10% COMP	01121	RCR32G472KS
R 009	0077298	RESISTOR 1 OHM 3W WW 5%	24681	VAL-3
R 010	0086963	RESISTOR 10 OHM 3W WW 5%		VAL3
R 011	0081051	RESISTOR .35 OHM 3W WW 5%	63743	RW69VR35
R 012	0081051	RESISTOR .35 OHM 3W WW 5%	63743	RW69VR35
R 013	0077146	RESISTOR .5 OHM 5W 5%	15915	TS5W-6706
R 014	0077146	RESISTOR .5 OHM 5W 5%	15915	TS5W-6706
R 015	0083410	RESISTOR .5 OHM 10W 1%	91637	RH-10
R 016	0083410	RESISTOR .5 OHM 10W 1%	91637	RH-10
R 017	0077146	RESISTOR .5 OHM 5W 5%	15915	TS5W-6706
R 018	0077146	RESISTOR .5 OHM 5W 5%	15915	TS5W-6706
R 019	0071984	RESISTOR 2,7K OHM 1W 10% COMP	01121	RCR32G272KS
R 020	0074704	RESISTOR 1,2K OHM 1W 10% COMP	01121	RCR32G122KS
R 021	0072004	RESISTOR 4,7K OHM 1W 10% COMP	01121	RCR32G472KS
T 001	0151475	POWER TRANSFORMER SERIES 1580		
TB001	0073001	TERMINAL STRIP 3 LUG CENTER GROUND	71785	52A
U 001	0083646	IC VLTG RGLTR NEG 5V 0,5A TYP T03	04713	MC7905CK
U 002	0083625	IC VLTG RGLTR POS 12V 0,5A TYP T03	04713	MC7812CK
W 001	0163097	CABLE ASSY POWER SUPPLY		
W 002	0163098	CABLE ASSY POWER SUPPLY		
W 003	0163099	CABLE ASSY POWER SUPPLY		
W 004	0163100	CABLE ASSY POWER SUPPLY		
XA001	0078225	CONNECTR 22 PIN DOUBLE READOUT	71785	251-22-30-160
XA002	0078225	CONNECTR 22 PIN DOUBLE READOUT	71785	251-22-30-160
XQ001	0085001	SOCKET TO-3 CASE		A1303
XQ002	0085001	SOCKET TO-3 CASE		A1303

POWER SUPPLY ASSEMBLY-163037

REF DESIG PREFIX A2

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
XQ003	0085001	SOCKET TO-3 CASE		A1303
XQ004	0085001	SOCKET TO-3 CASE		A1303
XQ005	0085001	SOCKET TO-3 CASE		A1303
XQ008	0085001	SOCKET TO-3 CASE		A1303
XQ009	0085001	SOCKET TO-3 CASE		A1303
XQ010	0085001	SOCKET TO-3 CASE		A1303
XQ011	0085001	SOCKET TO-3 CASE		A1303
XU001	0085001	SOCKET TO-3 CASE		A1303
XU002	0085001	SOCKET TO-3 CASE		A1303

REGULATOR PWB ASSEMBLY-158327

REF DESIG PREFIX A2A1

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	70501	CAPACITR 47 PF 1KV CER DISC	71590	DD-470
C02	70671	CAPACITR 100 MF 25V	80183	500D107G025DD7
C03	75217	CAPACITR 10 MF 50V	80183	500D106G050CB7
C04		NOT ASSIGNED		
C05		NOT ASSIGNED		
C06	35654	CAPACITR 10 MF 25V SOLID TANT POL 10%	05397	T362B106K025AS
C07	70671	CAPACITR 100 MF 25V	80183	500D107G025DD7
C08	70552	CAPACITR .002 MF 1KV CER DISC	71590	DD202
C09	70552	CAPACITR .002 MF 1KV CER DISC	71590	DD202
C10		NOT ASSIGNED		
C11		NOT ASSIGNED		
C12	70540	CAPACITR 470 PF 1KV CER DISC	71590	DD-471
C13	70501	CAPACITR 47 PF 1KV CER DISC	71590	DD-470
C14	70501	CAPACITR 47 PF 1KV CER DISC	71590	DD-470
C15	70671	CAPACITR 100 MF 25V	80183	500D107G025DD7
C16		NOT ASSIGNED		
C17	75217	CAPACITR 10 MF 50V	80183	500D106G050CB7
C18	70501	CAPACITR 47 PF 1KV CER DISC	71590	DD-470
C19	75219	CAPACITR 100-MF 50V	80183	500D107G050DH7
C20		NOT ASSIGNED		
C21	75217	CAPACITR 10 MF 50V	80183	500D106G050CB7
C22	35654	CAPACITR 10 MF 25V SOLID TANT POL 10%	05397	T362B106K025AS
C23	70501	CAPACITR 47 PF 1KV CER DISC	71590	DD-470
C24	75219	CAPACITR 100-MF 50V	80183	500D107G050DH7
C25		NOT ASSIGNED		
C26	70540	CAPACITR 470 PF 1KV CER DISC	71590	DD-471
Q1	76316	TRANSSTR 2N4036 PNP SIL	79089	2N4036S
Q2	76316	TRANSSTR 2N4036 PNP SIL	79089	2N4036S
R01		NOT ASSIGNED		
R02	76723	RESISTOR 39 OHM 1/4W 10% COMP	01121	RCR07G390KS
R03	79865	RESISTOR 12.4K OHM RN55C 1% MTL FLM		RN55C1242F
R04	78137	POT 2K OHM 3/4W CER RECT 3/4 LONG 15T	73138	3009P-1-202
R05	71928	RESISTOR 470 OHM 1W 10% COMP	01121	RCR32G471KS
R06	83893	RESISTOR 1.69K OHM RN55C 1% MTL FLM		RN55C1691F
R07	79744	RESISTOR 7.50K OHM RN55C 1% MTL FLM		RN55C7501F
R08	78934	RESISTOR 15.0K OHM RN55C 1% MTL FLM		RN55C1502F
R09	85748	POT 500 OHM 3/4W CER RECT 3/4 LONG 20T	80294	3009B-1-501
R10	74706	RESISTOR 1.5K OHM 1/4W 5% COMP	01121	RCR07G152JS
R11		NOT ASSIGNED		
R12	83898	RESISTOR 2.15K OHM RN55C 1% MTL FLM		RN55C2151F
R13	76275	RESISTOR 22 OHM 1/4W 10% COMP	01121	RCR07G220KS
R14	83828	RESISTOR 16.9 OHM RN55D 1% MTL FLM		RN55D16R9F
R15	79009	RESISTOR 2.80K OHM RN55C 1% MTL FLM		RN55C2801F
R16	76956	POT 1K OHM 3/4W CER RECT 3/4 LONG 15T	73138	3009P-1-102
R17	75589	RESISTOR 56 OHM 1W 10% COMP	01121	RCR32G560KS
R18	83893	RESISTOR 1.69K OHM RN55C 1% MTL FLM		RN55C1691F
R19	71970	RESISTOR 1.5K OHM 3W	24681	VAL3
R20	71970	RESISTOR 1.5K OHM 3W	24681	VAL3
R21		NOT ASSIGNED		
R22	83830	RESISTOR 18.7 OHM RN55D 1% MTL FLM		RN55D18R7F
R23	83924	RESISTOR 21.5K OHM RN55C 1% MTL FLM		RN55C2152F
R24	76980	POT 5K OHM 1w ww RECT 3/4 LONG 20T	80294	3005P-1-502
R25	75641	RESISTOR 680 OHM 2W 10% COMP	01121	RCR42G681KS
R26	75641	RESISTOR 680 OHM 2W 10% COMP	01121	RCR42G681KS
R27	83893	RESISTOR 1.69K OHM RN55C 1% MTL FLM		RN55C1691F
R28	79729	RESISTOR 13.0K OHM RN55C 1% MTL FLM		RN55C1302F
R29	83927	RESISTOR 26.1K OHM RN55C 1% MTL FLM		RN55C2612F
R30	71960	RESISTOR 1.2K OHM 1/4W 10% COMP	01121	RCR07G122KS
R31	85748	POT 500 OHM 3/4W CER RECT 3/4 LONG 20T	80294	3009B-1-501
R32	83898	RESISTOR 2.15K OHM RN55C 1% MTL FLM		RN55C2151F
R33		NOT ASSIGNED		
R34		NOT ASSIGNED		
R35	76275	RESISTOR 22 OHM 1/4W 10% COMP	01121	RCR07G220KS

REGULATOR PWB ASSEMBLY-158327

REF DESIG PREFIX A2A1

COMP DESIG	S-A PART NO	DESCRIPTION		FSCM	MFR PART NO
TP1	73318	WIRE 22 BUS		70903	8021
TP2	73318	WIRE 22 BUS		70903	8021
TP3	73318	WIRE 22 BUS		70903	8021
TP4	73318	WIRE 22 BUS		70903	8021
TP5	73318	WIRE 22 BUS		70903	8021
TP6	73318	WIRE 22 BUS		70903	8021
TP7	73318	WIRE 22 BUS		70903	8021
TP8	73318	WIRE 22 BUS		70903	8021
U1	78719	IC VLTG RGLTR +4.5 TO +40V .025A	TO5	12040	LM305AH
U2	78720	IC VLTG RGLTR 0 TO -30V .015A TYP	TO5	12040	LM304H TO-5
U3	78719	IC VLTG RGLTR +4.5 TO +40V .025A	TO5	12040	LM305AH
U4	78719	IC VLTG RGLTR +4.5 TO +40V .025A	TO5	12040	LM305AH
U5	81693	IC VLTG RGLTR 0 TO -40V .015A TYP	TO5	12040	LM104H

CHART & PEN SERVO PWB ASSY-219157

REF DESIG PREFIX A2A2

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	77319	CAPACITR .47 MF 200V MET PLYEST OVAL 10%	84411	X663F ECPD7S33 BKT
C02	70542	CAPACITR 680 PF 500V SILVER MICA 5%	14655	CD19FD681J03
C03	70482	CAPACITR 20 PF 1KV CER DISC	71590	DD200
C04	82952	CAPACITR 220 PF 1KV CER DISC	71590	DD-221
C05	77319	CAPACITR .47 MF 200V MET PLYEST OVAL 10%	84411	X663F ECPD7S33 BKT
C06	70542	CAPACITR 680 PF 500V SILVER MICA 5%	14655	CD19FD681J03
C07	70482	CAPACITR 20 PF 1KV CER DISC	71590	DD200
C08	82952	CAPACITR 220 PF 1KV CER DISC	71590	DD-221
C09	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C10	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C11	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C12	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C13	81098	CAPACITR .47 MF 50V CER MONO 20%	72982	8131-050-651-474M
C14	81098	CAPACITR .47 MF 50V CER MONO 20%	72982	8131-050-651-474M
C15	81101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
CR01	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR02	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR03	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR04	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR05	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR06	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR07	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR08	71122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR09	71122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR10	71122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR11	71122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR12	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR13	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR14	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR15	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR16	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR17	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR18	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR19	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR20	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR21	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR22	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR23	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR24	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR25	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR26	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR27	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR28	71142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
(5) CR29	71122	DIODE 1N914 SIL 75V 75MA	80368	1N914
Q1	80007	TRANSSTR 2N2102 NPN SIL	79089	2N2102
Q2	82857	TRANSSTR 2N4036 PNP SIL WITH LONG LEADS	79089	2N4036L LONG LEADS
Q3	80007	TRANSSTR 2N2102 NPN SIL	79089	2N2102
Q4	82857	TRANSSTR 2N4036 PNP SIL WITH LONG LEADS	79089	2N4036L LONG LEADS
Q5	81544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	01295	2N4856
Q6	81544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	01295	2N4856
R01	87290	POT 25K OHM 3/4W CER RECT 3/4 LONG 20T	73138	3009P-1-253
R02	79131	RESISTOR 150K OHM RN55C 1% MTL FLM		RN55C1502F
R03	72026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R04	72189	RESISTOR 1.0 MEG 1/4W 10% COMP	01121	RCR07G105KS
R05	83933	RESISTOR 38.3K OHM RN55C 1% MTL FLM		RN55C3832F
R06	83933	RESISTOR 38.3K OHM RN55C 1% MTL FLM		RN55C3832F
R07	83942	RESISTOR 75.0K OHM RN55C 1% MTL FLM		RN55C7502F
R08	83942	RESISTOR 75.0K OHM RN55C 1% MTL FLM		RN55C7502F
R09	72113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R10	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
R11	72113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R12	79929	RESISTOR 1.00K OHM RN55C 1% MTL FLM		RN55C1001F
R13	72207	RESISTOR 2.2 MEG 1/4W 10% COMP	01121	RCR07G225KS
R14	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R15	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R16	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R17	71887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R18	71929	RESISTOR 470 OHM 2W 10% COMP	01121	RCR42G471KS

CHART & PEN SERVO PWB ASSY-219157

REF DESIG PREFIX A2A2

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
R19	75625	RESISTOR 270 OHM 1W 10% COMP	01121	RCR32G271KS
R20	71887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R21	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R22	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
(4) R23	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
(4) R24	72054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
(5) R24	**72138**	**RESISTOR 220K OHM 1/4W 10% COMP**	**01121**	**RCR07G224KS**
R25	87290	POT 25K OHM 3/4W CER RECT 3/4 LONG 20T	73138	3009P-1-253
R26	79131	RESISTOR 150K OHM RN55C 1% MTL FLM		RN55C1502F
R27	72026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R28	72189	RESISTOR 1.0 MEG 1/4W 10% COMP	01121	RCR07G105KS
R29	83925	RESISTOR 22.6K OHM RN55C 1% MTL FLM		RN55C2262F
R30	83925	RESISTOR 22.6K OHM RN55C 1% MTL FLM		RN55C2262F
R31	79722	RESISTOR 90.9K OHM RN55C 1% MTL FLM		RN55C9092F
R32	79722	RESISTOR 90.9K OHM RN55C 1% MTL FLM		RN55C9092F
R33	83734	RESISTOR 82.5K OHM RN55C 1% MTL FLM		RN55C8252F
R34	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
R35	83734	RESISTOR 82.5K OHM RN55C 1% MTL FLM		RN55C8252F
R36	78929	RESISTOR 1.00K OHM RN55C 1% MTL FLM		RN55C1001F
R37	72207	RESISTOR 2.2 MEG 1/4W 10% COMP	01121	RCR07G225KS
R38	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R39	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R40	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R41	71887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R42	71929	RESISTOR 470 OHM 2W 10% COMP	01121	RCR42G471KS
R43	75625	RESISTOR 270 OHM 1W 10% COMP	01121	RCR32G271KS
R44	71887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
(3) R45	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
(3) R46	71887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
(1) R47	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
(1) R48	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
(2) R47	**71887**	**RESISTOR 100 OHM 1/4W 10% COMP**	**01121**	**RCR07G101KS**
(2) R48	**71887**	**RESISTOR 100 OHM 1/4W 10% COMP**	**01121**	**RCR07G101KS**
TP1	73318	WIRE 22 BUS	70903	8021
TP2	73318	WIRE 22 BUS	70903	8021
TP3	73318	WIRE 22 BUS	70903	8021
TP4		NOT ASSIGNED		
TP5	73318	WIRE 22 BUS	70903	8021
TP6	73318	WIRE 22 BUS	70903	8021
TP7	73318	WIRE 22 BUS	70903	8021
U1	173648	IC OP AMP 8L-T099 75C COMP WIDEBAND		HA2-2005-5
U2	173648	IC OP AMP 8L-T099 75C COMP WIDEBAND		HA2-2005-5

(1) Applies to Serial No. 324 and Below (Serial No. Approximate)

(2) Applies to Serial No. 325 and Above (Serial No. Approximate)

(3) Omitted After Serial No. 374 (Serial No. Approximate)

(4) Applies to Serial No. 16 through No. 374 (Serial No. Approximate)

(5) Applies to Serial No. 375 and Above (Serial No. Approximate)

DATA PROCESSOR ASSEMBLY - 158351

REF DESIG PREFIX A3

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A 01	151488	PWB ASSY CONTROL PANEL INTERFACE		
A 02	156088	PWB ASSY CPU BOARD		
(2) A 03	256211	PWB ASSY 1580 MEMORY (1)		
(2) A 04	256213	PWB ASSY 1580 MEMORY (2)		
A 03	156089	PWB ASSY MEMORY (1)		
A 04	164819	PWB ASSY MEMORY (2)		
A 05	158391	PWB ASSY CBA/DCA INTERFACE		
A 05	158455	PWB ASSY,DIGITAL INTERFACE		
A 06	151489	PWB ASSY,SYNCHRO TO DIGITAL CONVERTER		
A 06	158455	PWB ASSY,DIGITAL INTERFACE		
(1) A 07	252588	PWB ASSY IEEE INTERFACE 1580		
A 07	158498	PWB ASSY IEEE-488 INTERFACE		
A 08	158501	PWB ASSY 60DB INTERFACE		
A 09	158452	PWB ASSY PEN/CHART CONTROL		
A 10	158452	PWB ASSY PEN/CHART CONTROL		
A 11	162915	PWB ASSY SERVO RATE LOOP		
A 12	158363	MOTHER BOARD ASSY		

(1) APPLIES TO SERIAL NUMBER 278 AND ABOVE (APPROXIMATELY)

(2) APPLIES TO SERIAL NUMBER 402 AND ABOVE (APPROXIMATELY)

CONTROL PANEL INTERFACE ASSY-151488

REF DESIG PREFIX A3A1

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C02	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C03	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C04	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C05	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C06	70651	CAPACITR 25 MF 25V	80183	500D256D025CC7
C07	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
C08	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
C09	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
C10	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
J1	85971	SOCKET 16 PIN DIP PC MT LOW PROFILE		530177-2
J2	85971	SOCKET 16 PIN DIP PC MT LOW PROFILE		530177-2
J3	85971	SOCKET 16 PIN DIP PC MT LOW PROFILE		530177-2
J4	86648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
R1	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R2	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R3	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R4	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R5	71907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R6	71989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
U01	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U02	85114	RESISTOR NETWORK 13 3.3K OHM 2% 14 DIP	80294	4114R-002-332S
U03	87073	IC TTL LATCH NAND R/S QUAD		SN74LS279N
U04	87073	IC TTL LATCH NAND R/S QUAD		SN74LS279N
U05	85114	RESISTOR NETWORK 13 3.3K OHM 2% 14 DIP	80294	4114R-002-332S
U06	85114	RESISTOR NETWORK 13 3.3K OHM 2% 14 DIP	80294	4114R-002-332S
U07	84281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
U08	84285	IC TTL GATE OR 2-IN QUAD	01295	SN74LS32N
U09	85950	IC TTL LATCH 8-BIT TRANSPARENT 3-STATE		SN74LS373N
U10	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U11	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U12	85950	IC TTL LATCH 8-BIT TRANSPARENT 3-STATE		SN74LS373N
U13	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U14	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U15	85943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U16	83296	SWITCH SPST 9 POS PC MT DIP	00779	435166-5
U17	84281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
XU16	85971	SOCKET 16 PIN DIP PC MT LOW PROFILE		530177-2

CPU PRINTED WIRING BOARD ASSY 156088

REF DESIG PREFIX A3A2

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
(1) C 001	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	71590	DD102
(1) C 002	0073493	CAPACITR 18 PF 500V SILVER MICA 5%	14655	CD15CD180J03
(2) C 002	0073492	CAPACITR 15 PF 500V SILVER MICA 5%	00656	CD15CD150J03
(2) C 003	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	71590	DD102
C 004	0078998	CAPACITR 5 MF 25V	80183	500D505G025BA7
C 005	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 006	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 007	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 008	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 009	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 010	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
CR001	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
(3) L 001	0077954	INDUCTOR .47 UH SUBMIN UNSHLD 10%	91637	IR-2
L 001	0078718	INDUCTOR .429-.517 UH PC MOUNT		7107-09
R 001	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 002	0071836	RESISTOR 10 OHM 1/4W 10% COMP	01121	RCR07G100KS
R 003	0071836	RESISTOR 10 OHM 1/4W 10% COMP	01121	RCR07G100KS
R 004	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 005	0071836	RESISTOR 10 OHM 1/4W 10% COMP	01121	RCR07G100KS
R 006	0071836	RESISTOR 10 OHM 1/4W 10% COMP	01121	RCR07G100KS
R 007	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 008	0072093	RESISTOR 68K OHM 1/4W 10% COMP	01121	RCR07G683KS
R 009	0071887	RESISTOR 100 OHM 1/4W 10% COMP	01121	RCR07G101KS
R 010	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 011	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 012	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 013	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 014	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 015	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
U 001	0217704	HEAT SINK ASSY,MDL 1581 SPARE PARTS KIT		
U 002	0084285	IC TTL GATE OR 2-IN QUAD	01295	SN74LS32N
U 003	0084028	IC I/O PORT 8-BIT 3-STATE TTL		P8212
U 004	0084028	IC I/O PORT 8-BIT 3-STATE TTL		P8212
U 005	0087078	IC MICROPROCESSOR 16-BIT NMOS		TMS9900
U 006	0084028	IC I/O PORT 8-BIT 3-STATE TTL		P8212
U 007	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL		SN74LS243N
U 008	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL		SN74LS243N
U 009	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL		SN74LS243N
U 010	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL		SN74LS243N
XU001	0086897	SOCKET 20 PIN DIP PC MT		ICT-203-S-T
XU002	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU003	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU004	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU005	0087081	SOCKET 64 PIN DIP PC MT		ICN-649-S5-G
XU006	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU007	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU008	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU009	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU010	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
Y 001	0087079	CRYSTAL 48.0 MHZ .005% THIRD OVERTONE		MP480JK

(1) Applies to Serial No. 324 and Below (Serial No. Approximate)

(2) Applies to Serial No. 325 and Above (Serial No. Approximate)

(3) Applies to Serial Number 551 and Below (Approximately).

MEMORY 1 PWB ASSEMBLY - 256211

REF DESIG PREFIX A3A3

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C 001	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 006	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 007	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 008	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 009	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 010	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 011	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 012	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 013	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 014	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
R 001	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
U 001	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 002	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 003	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 004	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 005	0256210	PROGRAMMED EPROM		256210
U 006	0256210	PROGRAMMED EPROM		256210
U 007	0256210	PROGRAMMED EPROM		256210
U 008	0256210	PROGRAMMED EPROM		256210
U 009	0086647	IC TTL GATE AND 2-IN QUAD OPEN COL		SN74LS09N
U 010	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 011	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 012	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 013	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 014	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 015	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 016	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 017	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 018	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 019	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U 020	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
XU001	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU002	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU003	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU004	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU005	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU006	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU007	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU008	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU009	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU010	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU011	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU012	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU013	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU014	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU015	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU016	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU017	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU018	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU019	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU020	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T

MEMORY 2 PWB ASSEMBLY - 256213

REF DESIG PREFIX A3A4

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C 001	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 006	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 007	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 008	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 009	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 010	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 011	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 012	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 013	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 014	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
R 001	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
U 001	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 002	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 003	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 004	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 005	0256212	PROGRAMMED EPROM		256212
U 006	0256212	PROGRAMMED EPROM		256212
U 009	0086647	IC TTL GATE AND 2-IN QUAD OPEN COL		SN74LS09N
U 010	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 011	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 012	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 013	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC		9111BDC
U 014	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 015	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 016	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 017	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL		P8216
U 018	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
U 019	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U 020	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
XU001	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU002	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU003	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU004	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU005	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU006	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU007	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU008	0086651	SOCKET 24 PIN DIP PC MT		ICT-246-S-T
XU009	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU010	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU011	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU012	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU013	0086650	SOCKET 18 PIN DIP PC MT		ICT-183-S-T
XU014	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU015	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU016	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU017	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU018	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T
XU019	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU020	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T

CBA/DCA INTERFACE ASSY - OPTIONAL - 158391

REF DESIG PREFIX A3A5-OPTIONAL

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C02	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C03	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C04	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C05	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
C06	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C07	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C08	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C09	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C10	81210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C11	81210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C12	81101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C13	81210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-203K
C14	81101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
P1		NOT ASSIGNED		
P2	87082	CONN HEADER SGL ROW RT ANGLE 12-PIN PC		1-87233-2
P3	84629	CONN COZX SMC MALE PC MT RT ANGLE	26805	5064-0000-09
R01	84525	RESISTOR 3.9 MEG 1/4W 5% COMP		RCR07G395JS
R02	76933	POT 50K OHM 3/4W CER RECT 3/4 LONG 20T	73138	3009P-1-503
R03	76933	POT 50K OHM 3/4W CER RECT 3/4 LONG 20T	73138	3009P-1-503
R04	84525	RESISTOR 3.9 MEG 1/4W 5% COMP		RCR07G395JS
TP1	73318	WIRE 22 BUS	70903	8021
TP2	73318	WIRE 22 BUS	70903	8021
TP3	73318	WIRE 22 BUS	70903	8021
TP4	73318	WIRE 22 BUS	70903	8021
TP5	73318	WIRE 22 BUS	70903	8021
U1	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U2	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U3	86960	CONVERTER ANALOG TO DIGITAL 12 BIT BIN		ADC-HX12BGC
U4	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U5	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U6	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N

DIGITAL INTERFACE ASSEMBLY - OPTIONAL-158455

REF DESIG PREFIX A3A5-OPTIONAL

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C1	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C2	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C3	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C4	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C5	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C6	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
C7	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
U01	81658	IC TTL BUFFER HEX OPEN-COL	01295	SN7407N
U02	83510	RESISTOR NETWORK 13 22K OHM 2% 14 DIP	73138	899-1R-22K
U03	83510	RESISTOR NETWORK 13 22K OHM 2% 14 DIP	73138	899-1R-22K
U04	83510	RESISTOR NETWORK 13 22K OHM 2% 14 DIP	73138	899-1R-22K
U05	84281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
U06	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U07	85948	IC TTL FLIP-FLIP TYPE-D OCTAL		SN74LS377N
U08	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U09	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U10	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U11	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N

SYNCHRO TO DIGITAL CONVERTER INTERFACE ASSY - 151489

REF DESIG PREFIX A3A6-OPTIONAL

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C1	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C2	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C3	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C4	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C5	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C6	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C7	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C8	70532	CAPACITR 300 PF 500V SILVER MICA 5%	14655	CD15FD301J03
(2) D1	76448	DIODE IN4742A SI ZEN 12V 5% 1W	04713	IN4742A
D2	76448	DIODE IN4742A SI ZEN 12V 5% 1W	04713	IN4742A
P2	85614	SOCKET 14 PIN DIP PC MT	91506	514-AG11D
R1	71989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R2	71989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R3	71989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
(1) R4	71836	RESISTOR 10 OHM 1/4W 5% COMP	01121	RCR07G100KS
R5	71836	RESISTOR 10 OHM 1/4W 5% COMP	01121	RCR07G100KS
(2) R4	89040	RESISTOR 47 OHM 1/4W 5% CARBON FILM		
R5	89040	RESISTOR 47 OHM 1/4W 5% CARBON FILM		
U1	85934	CONVERTER SYNCHRO TO DIGITAL 10 BIT 12V		SDC-610C-H-1-12V-LX
U2	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U3	84279	IC TTL GATE NAND 2-IN QUAD	91295	SN74LS00N
U4	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U5	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U6	77709	IC TTL GATE NAND 2-IN QUAD	01295	SN7400N
U7	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N

(1) Applies to Serial No. 324 and Below (Serial No. Approximate)

(2) Applies to Serial No. 325 and Above (Serial No. Approximate)

DIGITAL INTERFACE ASSEMBLY - OPTIONAL-158455

REF DESIG PREFIX A3A6-OPTIONAL

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO-----
C1	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C2	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C3	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C4	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C5	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C6	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
C7	70534	CAPACITR 330 PF 500V SILVER MICA 5%	14655	CD15FD331J03
U01	81658	IC TTL BUFFER HEX OPEN-COL	01295	SN7407N
U02	83510	RESISTOR NETWORK 13 22K OHM 2% 14 DIP	73138	899-1R-22K
U03	83510	RESISTOR NETWORK 13 22K OHM 2% 14 DIP	73138	899-1R-22K
U04	83510	RESISTOR NETWORK 13 22K OHM 2% 14 DIP	73138	899-1R-22K
U05	84281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
U06	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U07	85948	IC TTL FLIP-FLIP TYPE-D OCTAL		SN74LS377N
U08	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U09	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U10	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U11	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N

IEEE-488 INTERFACE ASSEMBLY 252588

REF DESIG PREFIX A3A7

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C 001	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 006	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 007	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 008	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 009	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 010	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 011	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 012	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 013	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 014	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 015	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 016	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 017	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
C 018	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
(1) C 019	0070541	CAPACITR 500 PF 1KV CER DISC Z5F 10%	71590	DD 501
(1) C 020	0084214	CAPACITR .0015 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-152K
J 001	0084357	CONN HEADER DBL ROW RT ANGLE 20-PIN PC	00779	1-87230-0
(1) L 001	0078716	INDUCTOR 100 UH SUBMIN UNSHLD 10%	91637	IR-2
(1) Q 001	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
R 001	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 002	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	01121	RCR07G392KS
R 003	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 004	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
(1) R 005	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
(1) R 006	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	01121	RCR07G392KS
TP001	0073318	WIRE 22 BUS	70903	8021
TP002	0073318	WIRE 22 BUS	70903	8021
TP003	0073318	WIRE 22 BUS	70903	8021
U 001	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	01295	MC3448P
U 002	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	00779	MC3448P
U 003	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE	80294	MC3448P
U 004	0086901	IC BUS TRANSCVR IEEE 488 INTERFACE		MC3448P
U 005	0084281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
U 006	0086900	IC BUS TRANSCVR IEEE 488 INTERFACE		MC68488L
U 007	0083296	SWITCH SPST 8 POS PC MT DIP	01295	435166-5
U 008	0085114	RESISTOR NETWORK 13 3.3K OHM 2% 14 DIP		4114R-002-332
U 009	0085949	IC TTL BUFFER OCTAL 3-STATE	01295	SN74LS244N
U 010	0084282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U 011	0084283	IC TTL FLIP-FLOP TYPE-D DUAL		SN74LS74AN
U 012	0085946	IC TTL GATE NAND 3-IN TRIPLE		SN74LS10N
U 013	0084280	IC TTL GATE NOR 2-IN QUAD		SN74LS02N
U 014	0085088	IC TTL COUNTER BIN 3-MHZ		SN74LS93N
U 015	0087077	IC TTL CLOCK 4-PHASE		SN74LS362J
U 016	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 017	0085949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U 018	0085949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U 019	0085949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U 020	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 021	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 022	0085943	IC TTL DECODER 3-BIT TO 1 OF 8		SN74LS138N
XU006	0086653	SOCKET 40 PIN DIP PC MT		ICT-406-S-T
XU007	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T

(1) Applies to Serial No. 350 and Above (Serial No. Approximate)

60 OB INTERFACE ASSEMBLY 158501

REF DESIG PREFIX A3A8

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO-----
C01	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C02	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C03	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C04	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C05	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C06	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C07	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C08	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C09	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C10	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C11	81210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C12	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
CR1	79617	DIODE 1N827 TC REF 6.2V .001% .4W	04713	1N827
P1		NOT ASSIGNED		
P2	84629	CONN COAX SMC MALE PC MT RT ANGLE	26805	5064-0000-09
R01	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R02	83882	RESISTOR 909 OHM RN55C 1% MTL FLM		RN55C9090F
R03	78933	RESISTOR 10.0K OHM RN55C 1% MTL FLM		RN55C1002F
R04	76596	POT 10K OHM 1W WW RECT 3/4 LONG 20T	80294	3005P-1-103
R05	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R06	78933	RESISTOR 10.0K OHM RN55C 1% MTL FLM		RN55C1002F
R07	78929	RESISTOR 1.00K OHM RN55C 1% MTL FLM		RN55C1001F
R08	76595	POT 1K OHM 1W WW RECT 3/4 LONG 20T	80294	3005P-1-102
R09	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R10	83892	RESISTOR 1.54K OHM RN55C 1% MTL FLM		RN55C1541F
R11	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R12	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R13	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
TP1	73318	WIRE 22 BUS	70903	8021
U1	85948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U2	86302	IC D/A CONVERTER 10-BIT MULTIPLYING		MC3410CL
U3	81595	IC OP AMP 8L-TO5 125C COMP 741	12040	LM741H
U4	85948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U5	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U6	84281	IC TTL GATE INVERTER HEX	01295	SN74LS04N

PEN/CHART CONTROL ASSEMBLY 158452

REF DESIG PREFIX A3A9

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C02	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C03	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C04	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C05	70541	CAPACITR 500 PF 1KV CER DISC	71590	DD 501
C06	70541	CAPACITR 500 PF 1KV CER DISC	71590	DD 501
C07	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C08	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C09	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C10	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C11	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C12	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C13	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C14	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C15	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C16	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C17	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C18	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C19	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C20	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C21	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C22	75417	CAPACITR .01 MF 150V CER DISC	71590	DDM-103
C23	75417	CAPACITR .01 MF 150V CER DISC	71590	DDM-103
C24	81995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
CR1	79617	DIODE 1N827 TC REF 6.2V .001% .4W	04713	1N827
R01	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R02	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R03	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R04	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R05	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R06	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R07	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R08	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R09	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R10	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R11	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R12	80380	RESISTOR 2.74K OHM RN55C 1% MTL FLM		RN55C2741F
R13	76595	POT 1K OHM 1W WW RECT 3/4 LONG 20T	80294	3005P-1-102
R14	83892	RESISTOR 1.54K OHM RN55C 1% MTL FLM		RN55C1541F
R15	83882	RESISTOR 909 OHM RN55C 1% MTL FLM		RN55C9090F
R16	79713	RESISTOR 2.00K OHM RN55C 1% MTL FLM		RN55C2001F
R17	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R18	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R19	72113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R20	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R21	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
TP1	73318	WIRE 22 BUS	70903	8021
TP2	73318	WIRE 22 BUS	70903	8021
TP3	73318	WIRE 22 BUS	70903	8021
TP4	73318	WIRE 22 BUS	70903	8021
U01	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U02	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U03	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U04	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U05	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U06	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U07	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U08	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U09	87074	IC TTL FLIP-FLOP TYPE-D QUAD		SN74LS379N
U10	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U11	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U12	86302	IC D/A CONVERTER 10-BIT MULTIPLYING		MC3410CL
U13	87074	IC TTL FLIP-FLOP TYPE-D QUAD		SN74LS379N
U14	85948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U15	81595	IC OP AMP 8L-TO5 125C COMP 741	12040	LM741H
U16	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N

PEN/CHART CONTROL ASSEMBLY 158452

REF DESIG PREFIX A3A9

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
U17	85114	RESISTOR NETWORK 13 3.3K OHM 2% 14 DIP	80294	4114R-002-332S
U18	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U19	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U20	80442	IC TTL GATE NAND 2-IN QUAD OPEN COL	01295	SN7403N
U21	80979	IC TTL BUFFER INVERT HEX OPEN-COL	01295	SN7406N
U22	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U23	80442	IC TTL GATE NAND 2-IN QUAD OPEN COL	01295	SN7403N
U24	80979	IC TTL BUFFER INVERT HEX OPEN-COL	01295	SN7406N
U25	81025	IC TTL GATE AND 2-IN QUAD	01295	SN7408N
U26	87075	IC TTL SCHMITT TRIGGER-INVERTER HEX		SN74LS14N

PEN/CHART CONTROL ASSEMBLY 158452

REF DESIG PREFIX A3A10

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C02	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C03	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C04	77256	CAPACITR 470 PF 100V SILVER MICA 5%	14655	CD7FA471J03
C05	70541	CAPACITR 500 PF 1KV CER DISC	71590	DD 501
C06	70541	CAPACITR 500 PF 1KV CER DISC	71590	DD 501
C07	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C08	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C09	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C10	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C11	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C12	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C13	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C14	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C15	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C16	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C17	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C18	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C19	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C20	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C21	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C22	75417	CAPACITR .01 MF 150V CER DISC	71590	DDM-103
C23	75417	CAPACITR .01 MF 150V CER DISC	71590	DDM-103
C24	81995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
CR1	79617	DIODE 1N827 TC REF 6.2V .001% .4W	04713	1N827
R01	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R02	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R03	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R04	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R05	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R06	72011	RESISTOR 5.6K OHM 1/4W 10% COMP	01121	RCR07G562KS
R07	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R08	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R09	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R10	79725	RESISTOR 3.16K OHM RN55C 1% MTL FLM		RN55C3161F
R11	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R12	80390	RESISTOR 2.74K OHM RN55C 1% MTL FLM		RN55C2741F
R13	76595	POT 1K OHM 1w WW RECT 3/4 LONG 20T	80294	3005P-1-102
R14	83892	RESISTOR 1.54K OHM RN55C 1% MTL FLM		RN55C1541F
R15	83882	RESISTOR 909 OHM RN55C 1% MTL FLM		RN55C9090F
R16	79713	RESISTOR 2.00K OHM RN55C 1% MTL FLM		RN55C2001F
R17	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R18	71862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R19	72113	RESISTOR 100K OHM 1/4W 10% COMP	01121	RCR07G104KS
R20	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R21	71951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
TP1	73318	WIRE 22 BUS	70903	8021
TP2	73318	WIRE 22 BUS	70903	8021
TP3	73318	WIRE 22 BUS	70903	8021
TP4	73318	WIRE 22 BUS	70903	8021
U01	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U02	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U03	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U04	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U05	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U06	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U07	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U08	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U09	87074	IC TTL FLIP-FLOP TYPE-D QUAD		SN74LS379N
U10	85942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U11	85949	IC TTL BUFFER OCTAL 3-STATE		SN74LS244N
U12	86302	IC D/A CONVERTER 10-BIT MULTIPLYING		MC3410CL
U13	87074	IC TTL FLIP-FLOP TYPE-D QUAD		SN74LS379N
U14	85948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U15	81595	IC OP AMP 8L-TO5 125C COMP 741	12040	LM741H
U16	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N

PEN/CHART CONTROL ASSEMBLY 158452

REF DESIG PREFIX A3A10

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
U17	85114	RESISTOR NETWORK 13 3.3K OHM 2% 14 DIP	30294	4114R-002-332S
U18	84282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N
U19	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U20	80442	IC TTL GATE NAND 2-IN QUAD OPEN COL	01295	SN7403N
U21	80979	IC TTL BUFFER INVERT HEX OPEN-COL	01295	SN7406N
U22	84279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U23	80442	IC TTL GATE NAND 2-IN QUAD OPEN COL	01295	SN7403N
U24	80979	IC TTL BUFFER INVERT HEX OPEN-COL	01295	SN7406N
U25	81025	IC TTL GATE AND 2-IN QUAD	01295	SN7408N
U26	87075	IC TTL SCHMITT TRIGGER-INVERTER HEX		SN74LS14N

SERVO RATE LOOP ASSEMBLY 162915

REF DESIG PREFIX A3A11

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C01	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C02	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C03	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C04	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C05	70651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C06	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C07	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C08	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C09	78700	FACTORY SELECTED VALUE		
C10	80144	CAPACITR 430 PF 500V SILVER MICA 1%	53021	D155C431F03
C11	83026	CAPACITR .010 MF 100V DIPPED MYLAR 5%	72136	MDE103JB2A
C12	85149	CAPACITR .047 MF 100V DIPPED MYLAR 5%	72136	MDE473JB2A
C13	78700	FACTORY SELECTED VALUE		
C14	80144	CAPACITR 430 PF 500V SILVER MICA 1%	53021	D155C431F03
C15	83026	CAPACITR .010 MF 100V DIPPED MYLAR 5%	72136	MDE103JB2A
C16	85149	CAPACITR .047 MF 100V DIPPED MYLAR 5%	72136	MDE473JB2A
C17	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C18	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C19	78700	FACTORY SELECTED VALUE		
C20	80144	CAPACITR 430 PF 500V SILVER MICA 1%	53021	D155C431F03
C21	83026	CAPACITR .010 MF 100V DIPPED MYLAR 5%	72136	MDE103JB2A
C22	85149	CAPACITR .047 MF 100V DIPPED MYLAR 5%	72136	MDE473JB2A
C23	78700	FACTORY SELECTED VALUE		
C24	80144	CAPACITR 430 PF 500V SILVER MICA 1%	53021	D155C431F03
C25	83026	CAPACITR .010 MF 100V DIPPED MYLAR 5%	72136	MDE103JB2A
C26	85149	CAPACITR .047 MF 100V DIPPED MYLAR 5%	72136	MDE473JB2A
C27	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C28	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C29	80139	CAPACITR .1 MF 50V CER MONO	72982	8131-050-651-104Z
C30	70532	CAPACITR 300 PF 500V SILVER MICA 5%	14655	CD15FD301J03
C31	70532	CAPACITR 300 PF 500V SILVER MICA 5%	14655	CD15FD301J03
C32	70532	CAPACITR 300 PF 500V SILVER MICA 5%	14655	CD15FD301J03
C33	70532	CAPACITR 300 PF 500V SILVER MICA 5%	14655	CD15FD301J03
P01		NOT ASSIGNED		
P02	87491	CONN HEADER SGL ROW RT ANGLE 9-PIN PC		87233-9
	74710	RESISTOR 2.2K OHM 1/4W 5% COMP	01121	RCR07G222JS
R01	75674	RESISTOR 15K OHM 1/4W 5% COMP	01121	RCR07G153JS
R02	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R03	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R04	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R05	74727	RESISTOR 10K OHM 1/4W 5% COMP	01121	RCR07G103JS
R06	83942	RESISTOR 75.0K OHM RN55C 1% MTL FLM		RN55C7502F
R07	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
R08	74714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R09	83921	RESISTOR 17.8K OHM RN55C 1% MTL FLM		RN55C1782F
R10	74710	RESISTOR 2.2K OHM 1/4W 5% COMP	01121	RCR07G222JS
R11	75674	RESISTOR 15K OHM 1/4W 5% COMP	01121	RCR07G153JS
R12	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R13	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R14	74727	RESISTOR 10K OHM 1/4W 5% COMP	01121	RCR07G103JS
R15	83942	RESISTOR 75.0K OHM RN55C 1% MTL FLM		RN55C7502F
R16	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
R17	74714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R18	83921	RESISTOR 17.8K OHM RN55C 1% MTL FLM		RN55C1782F
R19	79718	RESISTOR 35.7K OHM RN55C 1% MTL FLM		RN55C3572F
R20	79718	RESISTOR 35.7K OHM RN55C 1% MTL FLM		RN55C3572F
R21	74710	RESISTOR 2.2K OHM 1/4W 5% COMP	01121	RCR07G222JS
R22	75674	RESISTOR 15K OHM 1/4W 5% COMP	01121	RCR07G153JS
R23	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R24	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R25	74727	RESISTOR 10K OHM 1/4W 5% COMP	01121	RCR07G103JS
R26	83942	RESISTOR 75.0K OHM RN55C 1% MTL FLM		RN55C7502F
R27	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM		RN55C3322F
R28	74714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R29	83921	RESISTOR 17.8K OHM RN55C 1% MTL FLM		RN55C1782F
R30	74710	RESISTOR 2.2K OHM 1/4W 5% COMP	01121	RCR07G222JS
R31	75674	RESISTOR 15K OHM 1/4W 5% COMP	01121	RCR07G153JS
R32	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R33	74698	RESISTOR 560 OHM 1/4W 5% COMP	01121	RCR07G561JS
R34	74727	RESISTOR 10K OHM 1/4W 5% COMP	01121	RCR07G103JS

SERVO RATE LOOP ASSEMBLY 162915

REF DESIG PREFIX A3A11

COMP DESIG	S-A PART NO	DESCRIPTION		FSCM	MFR PART NO
R35	83942	RESISTOR 75.0K OHM RN55C 1% MTL FLM			RN55C7502F
R36	83931	RESISTOR 33.2K OHM RN55C 1% MTL FLM			RN55C3322F
R37	74714	RESISTOR 3.3K OHM 1/4W 5% COMP		01121	RCR07G332JS
R38	83921	RESISTOR 17.8K OHM RN55C 1% MTL FLM			RN55C1782F
R39	79718	RESISTOR 35.7K OHM RN55C 1% MTL FLM			RN55C3572F
R40	79718	RESISTOR 35.7K OHM RN55C 1% MTL FLM			RN55C3572F
TP1	73318	WIRE 22 BUS		70903	8021
TP2	73318	WIRE 22 BUS		70903	8021
TP3	73318	WIRE 22 BUS		70903	8021
TP4	73318	WIRE 22 BUS		70903	8021
TP5	73318	WIRE 22 BUS		70903	8021
TP6	73318	WIRE 22 BUS		70903	8021
TP7	73318	WIRE 22 BUS		70903	8021
TP8	73318	WIRE 22 BUS		70903	8021
U01	85088	IC TTL COUNTER BIN 3-MHZ		01295	SN74LS93N
U02	87063	IC CONVERTER FREQUENCY TO VOLTAGE			LM2917N
U03	87063	IC CONVERTER FREQUENCY TO VOLTAGE			LM2917N
U04	78977	IC OP AMP 8L-TO5 70C COMP	741C	04713	MC1741CG
U05	85088	IC TTL COUNTER BIN 3-MHZ		01295	SN74LS93N
U06	87063	IC CONVERTER FREQUENCY TO VOLTAGE			LM2917N
U07	87063	IC CONVERTER FREQUENCY TO VOLTAGE			LM2917N
U08	78977	IC OP AMP 8L-TO5 70C COMP	741C	04713	MC1741CG
U09	85943	IC TTL DECODER 3-BIT TO 1 OF 8			SN74LS138N
U10	84285	IC TTL GATE OR 2-IN QUAD		01295	SN74LS32N
U11	84281	IC TTL GATE INVERTER HEX		01295	SN74LS04N
U12	84281	IC TTL GATE INVERTER HEX		01295	SN74LS04N

MOTHERBOARD ASSEMBLY 158363

REF DESIG PREFIX A3A12

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
C 001	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 002	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 003	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
J 012	0087064	CONN HEADER SGL ROW RT ANGLE 5-PIN PC		87233-5
J 013	0087064	CONN HEADER SGL ROW RT ANGLE 5-PIN PC		87233-5
Q 001	0076316	TRANSSTR 2N4036 PNP SIL	79089	2N4036S
Q 002	0081544	TRANSSTR 2N4856 SIL FET N-CHNL JUNC	01295	2N4856
R 001	0074714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 002	0074727	RESISTOR 10K OHM 1/4W 5% COMP	01121	RCR07G103JS
R 003	0074675	RESISTOR 100 OHM 1/4W 5% COMP	01121	RCR07G101JS
R 004	0074735	RESISTOR 22K OHM 1/4W 5% COMP	01121	RCR07G223JS
W 001	0163096	CABLE ASSY		
XA001	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA002	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA003	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA004	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA005	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA006	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA007	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA008	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA009	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA010	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA011	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3

1580

S/D TRANSFORMER MODULE ASSY-163072

REF DESIG PREFIX A5

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A1	158383	PWB ASSY S/D XFORMER MODULE		
F1	71212	FUSE 1/8 AMP	75915	3AG 312.125
J1	70903	CONNECTR 3102A 20 7S	02660	MS3102A-20-7S
J2	70873	CONNECTR 3102A 14S 2S	02660	MS3102A-14S-2S
W1	218913	CABLE ASSY S/D TRANSFORMER		
XF1	71249	FUS HLDR PNL MT FOR 3AG OR 3AB	71400	HKP

S/D MODULE BOARD ASSY-158383

REF DESIG PREFIX A5A1

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
A1	85935	CIRCUIT MODULAR REF TRANSFORMER SCOTT-T		SDC-601
J1	85014	SOCKET 14 PIN DIP PC MT	91506	914-AG11D

DIGITAL INTERFACE PANEL ASSEMBLY - 162121

REF DESIG PREFIX A6

COMP DESIG	S-A PART NO	DESCRIPTION	FSCM	MFR PART NO
W01	164820	CABLE ASSY DIGITAL INTERFACE		
W02	164820	CABLE ASSY DIGITAL INTERFACE		
W03	164857	CABLE ASSY IEEE-488 INTERFACE		
W04	164858	CABLE ASSY 600B OPTION INTERFACE		

FSCM MANUFACTURER CROSS REFERENCE

FSCM	MANUFACTURER	CITY	STATE
00779	AMP INC	HARRISBURG	PA
01121	ALLEN-BRADLEY CO	MILWAUKEE	WISC
01295	TEXAS INSTRUMENTS INC	DALLAS	TEXAS
02660	AMPHENOL CORP	BROADVIEW	ILL
04713	MOTOROLA SEMICONDUCTOR PDTS	PHOENIX	ARIZ
05397	KEMET DIV-UNION CARBIDE	CLEVELAND	OHIO
10110	SCIENTIFIC-ATLANTA INC	ATLANTA	GA
11384	INLAND MOTOR CORP OF VA	RADFORD	VA
12040	NATIONAL SEMICONDUCTOR CORP	DANBURY	CONN
14655	CORNELL-DUBILIER ELEC CORP	S PLAINFIELD	NJ
15915	TEPRO OF FLORIDA INC	DUNEDIN	FLA
24152	S & E I MFG CO	NORTHRIDGE	CA
24681	MEMCOR INC COMPONENTS DIV /TRU-OHM/	HUNTINGTON	IND
26805	AMERICON CORP	WALTHAM	MA
37942	MALLORY P R & CO INC	INDIANAPOLIS	IND
44655	OHMITE MFG CO	SKOKIE	ILL
53021	SANGAMO ELECTRIC CO	SPRINGFIELD	ILL
63743	WARD-LEONARD ELECTRIC CO	MT VERNON	NY
70903	BELDEN MANUFACTURING CO	CHICAGO	ILL
71400	BUSSMAN MANUFACTURING	ST LOUIS	MO
71590	CENTRALAB	MILWAUKEE	WISC
71785	CINCH MANUFACTURING CO	CHICAGO	ILL
72136	ELECTRO MOTIVE CORP	FLORENCE	SC
72982	ERIE RESISTOR CORP	ERIE	PA
73138	HELIPOT-DIV BECKMAN INSTR	FULLERTON	CALIF
74970	JOHNSON E F CO	WASECA	MINN
75915	LITTLEFUSE INC	DES PLAINES	ILL
79089	RADIO CORP OF AMERICA	HARRISON	NJ
80183	SPRAGUE PDTS CO	CHICAGO	ILL
80294	BOURNS LABORATORIES INC	RIVERSIDE	CALIF
80368	SYLVANIA ELECTRIC PDTS INC	NEW YORK	NY
82768	PHILLIPS CONTROL CORP	JOLIET	ILL
83003	VARO INC	GARLAND	TEXAS
84411	TRW CAPACITOR DIV /GOOD-ALL/	OGALLALA	NEB
91506	AUGAT BROTHERS INC	ATTELBORO	MASS
91637	DALE PRODUCTS INC	COLUMBUS	NEB
91929	MICRO SWITCH	FREEPORT	ILL
95987	WECKESSER CO INC	CHICAGO	ILL
99743	IMC MAGNETICS CORP	WESTBURY	NY

CHAPTER 7
DIAGRAMS

7.1 GENERAL

7.1.1 The diagrams contained in this chapter are provided for both detailed maintenance and troubleshooting if a malfunction should occur and as a training aid for maintenance personnel who will be responsible for the care and operation of the Series 1580 Pattern Recorder.

7.2 ARRANGEMENT OF DIAGRAMS

7.2.1 The diagrams are arranged using the alpha-numeric designations assigned to the assemblies and subassemblies.

7.3 INDEX OF DIAGRAMS

7.3.1 The schematic and assembly diagrams contained in this chapter are arranged as follows:

LIST OF DIAGRAMS

SERIES 1580 PATTERN RECORDER

Figure		Title	Page
7-1		Figure Reference Index Using a Drawing Tree Arrangement	7-7
7-2		General Assembly Outline	7-8
7-3		Intercabling Identification	7-8
7-4		Recorder Head Assembly (A1), Outline Drawing	7-9
7-5		Recorder Head Assembly (A1), Schematic	7-10
7-5a		Recorder Head Assembly (A1), Schematic	7-11
7-6		Recorder Head Assembly (A1), Wiring and Cable Diagram	7-12
7-6a	(1)	Recorder Head Assembly (A1), Wiring and Cable Diagram	7-12a
7-7		Recording Head Subassembly (A1A1), Component Location	7-13
7-8		Pen Calibrate Printed Circuit Board (A1A1A2), Component Location	7-14
7-9		Pen Calibrate Printed Circuit Board (A1A1A2), Schematic	7-14
7-10		Pen Control Panel (A1A1A3), Component Location	7-15
7-11		Pen Control Panel (A1A1A3), Schematic	7-15
7-12		Chart Control Panel (A1A1A4), Component Location	7-16
7-13		Chart Control Panel (A1A1A4), Schematic	7-16
7-14		Bottom Paper Sensor (A1A1A5), Component Location	7-17
7-14a		Bottom Paper Sensor (A1A1A5), Component Location	7-17

(1) Applies to Serial Number 536 and above (approximately).

Figure	Title	Page
	POWER SUPPLY ASSEMBLY (A2)	7-19
7-15	Power Supply Assembly (A2), Component Location	7-20
7-16	Power Supply Assembly (A2), Schematic	7-21
7-17	Voltage Regulator Printed Circuit Board (A2A1), Component Location	7-22
7-18	Voltage Regulator Printed Circuit Board (A2A1), Schematic	7-22
7-19	System Servo Amplifier Printed Circuit Board (A2A2), Component Location (Applies to Serial Numbers 16 through 374)	7-23
7-20	System Servo Amplifier Printed Circuit Board (A2A2), Schematic (Applies to Serial Numbers 16 through 374)	7-23
7-19a	System Servo Amplifier Printed Circuit Board (A2A2), Component Location (Applies to Serial Numbers 375 and Above)	7-24
7-20a	System Servo Amplifier Printed Circuit Board (A2A2), Schematic (Applies to Serial Numbers 375 and Above)	7-24
	DATA PROCESSOR ASSEMBLY (A3)	7-25
7-21	Data Processor Assembly (A3), Component Location	7-26
7-22	Power Supply Assembly (A2) and Data Processor Assembly (A3) Components With Safety Covers Removed	7-26
7-23	Control Panel Interface Printed Circuit Board (A3A1), Component Location	7-27
7-24	Control Panel Interface Printed Circuit Board (A3A1), Schematic (2 Sheets)	7-28
7-25	Central Processor Unit (CPU) Printed Circuit Board (A3A2), Component Location	7-30

Figure	Title	Page
7-26	Central Processor Unit (CPU) Printed Circuit Board (A3A2), Schematic	7-31
7-27	Main Memory (1) Printed Circuit Board (A3A3), Component Location (Applies to Serial Numbers 401 and Below)	7-32
7-27a	Main Memory (1) Printed Circuit Board (A3A3), Component Location (Applies to Serial Numbers 402 and Above)	7-33
7-28	Main Memory (1) Printed Circuit Board (A3A3), Schematic (3 Sheets)	7-34
7-29	Optional Memory (2) Printed Circuit Board (A3A4), Component Location (Applies to Serial Numbers 401 and Below)	7-37
7-29a	Optional Memory (2) Printed Circuit Board (A3A4), Component Location (Applies to Serial Numbers 402 and Above)	7-38
7-30	Optional Memory (2) Printed Circuit Board (A3A4), Schematic (3 Sheets)	7-39
7-31	Optional CBA/DCA Interface Printed Circuit Board (A3A5), Component Location	7-42
7-32	Optional CBA/DCA Interface Printed Circuit Board (A3A5), Schematic	7-43
7-33	Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Component Location (Applies to Serial Numbers 324 and Below)	7-44
7-34	Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Schematic (Applies to Serial Numbers 324 and Below)	7-44
7-33a	Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Component Location (Applies to Serial Numbers 325 and Above)	7-45
7-34a	Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Schematic (Applies to Serial Numbers 325 and Above)	7-45

Figure	Title	Page
7-35	Optional Digital Interface Printed Circuit Board (A3A6), Component Location	7-46
7-36	Optional Digital Interface Printed Circuit Board (A3A6), Schematic	7-47
7-37	Optional IEEE-488 Interface Printed Circuit Board (A3A7), Component Location (Applies to Serial Numbers 349 and Below)	7-48
7-38	Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic (Applies to Serial Numbers 349 and Below)	7-49
7-37a	Optional IEEE-488 Interface Printed Circuit Board (A3A7), Component Location (Applies to Serial Numbers 350 and Above)	7-50
7-38a	Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic (Applies to Serial Numbers 350 and Above)	7-51
7-39	60 dB Option Printed Circuit Board (A3A8), Component Location	7-52
7-40	60 dB Option Printed Circuit Board (A3A8), Schematic	7-53
7-41	Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Component Location	7-55
7-42	Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (2 Sheets)	7-56
7-43	Servo Rate Loop Printed Circuit Board (A3A11), Component Location	7-58
7-44	Servo Rate Loop Printed Circuit Board (A3A11), Schematic	7-59
7-45	Motherboard Printed Circuit Board (A3A12), Component Location	7-60
7-46	Motherboard Printed Circuit Board (A3A12), Schematic	7-61

Figure	Title	Page
	ASSEMBLIES A5, A5A1, A6, AND CABLES	7-63
7-47	Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Component Location	7-64
7-48	Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Schematic	7-64
7-49	Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Component Location	7-65
7-50	Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Schematic	7-65
7-51	Optional Digital Interface Panel (A6), Assembly Outline and Cable Identification	7-66
7-52	Optional Digital Interface Panel (A6), Pin-Out Identification for Cables A6W1 and A6W2	7-66
7-53	Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W3	7-67
7-54	Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W4	7-67

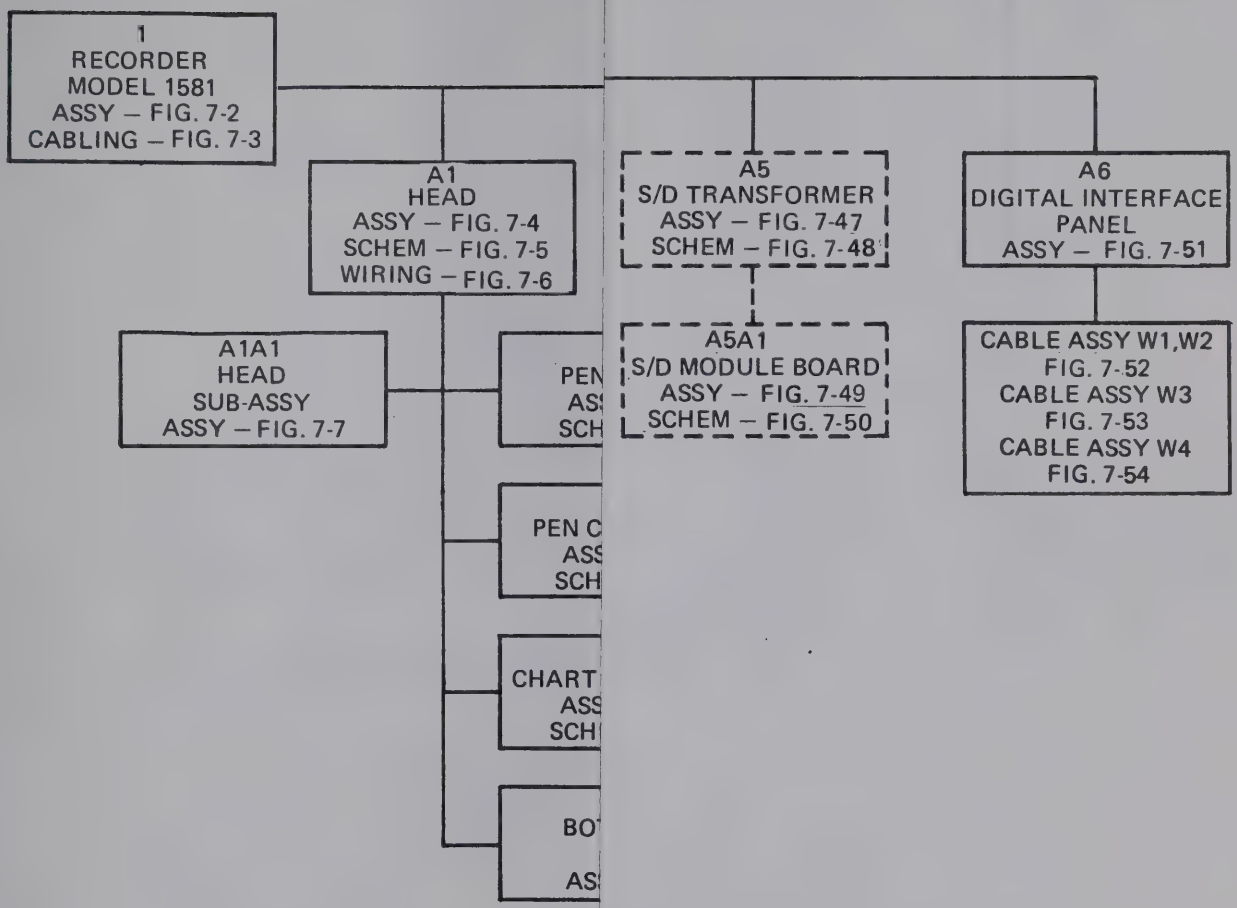


Figure 7-1. Figure Reference Index Using a Drawing Tree Arrangement

Figure	Title	Page
	ASSEMBLIES A5, A5A1, A6, AND CABLES	7-63
7-47	Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Component Location	7-64
7-48	Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Schematic	7-64
7-49	Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Component Location	7-65
7-50	Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Schematic	7-65
7-51	Optional Digital Interface Panel (A6), Assembly Outline and Cable Identification	7-66
7-52	Optional Digital Interface Panel (A6), Pin-Out Identification for Cables A6W1 and A6W2	7-66
7-53	Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W3	7-67
7-54	Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W4	7-67

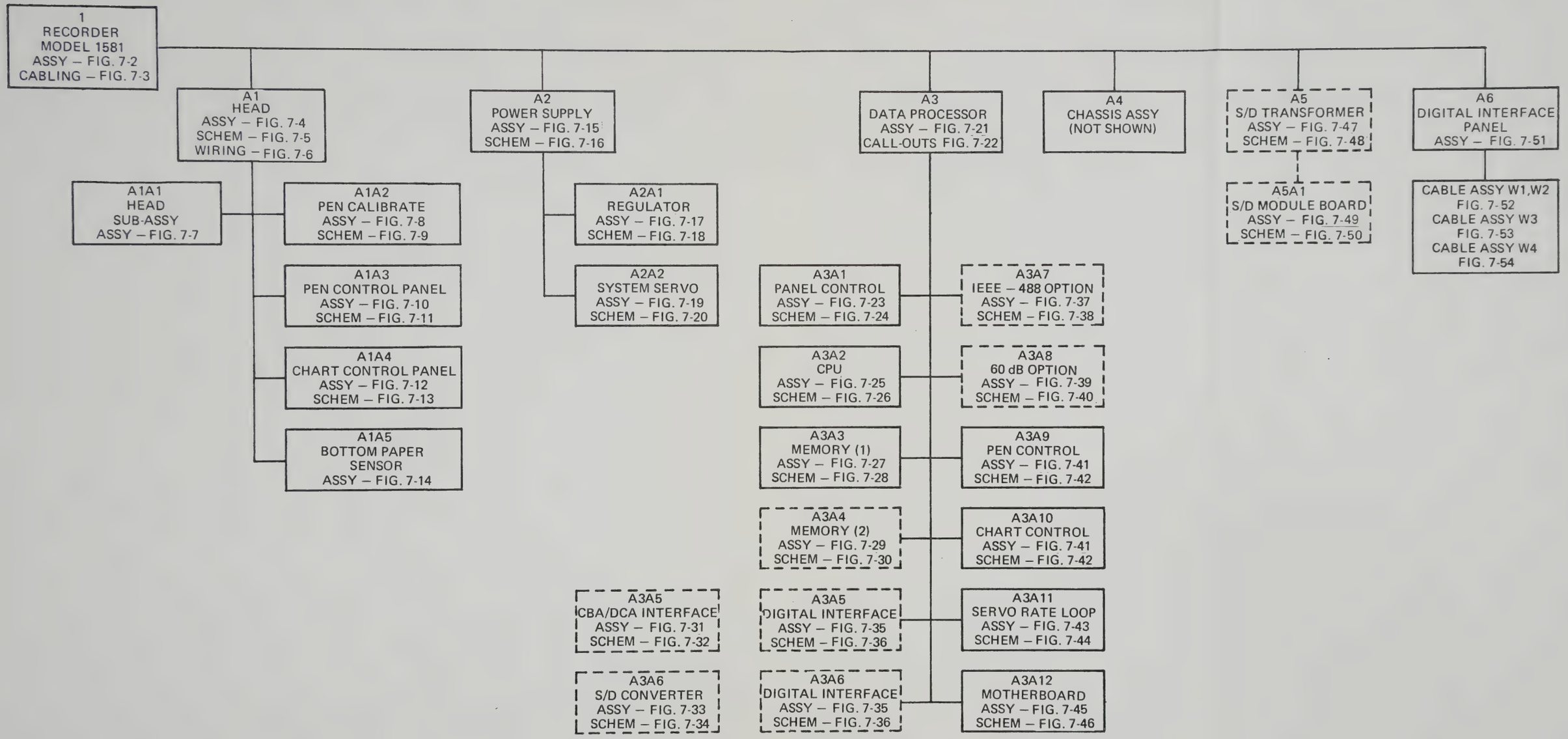
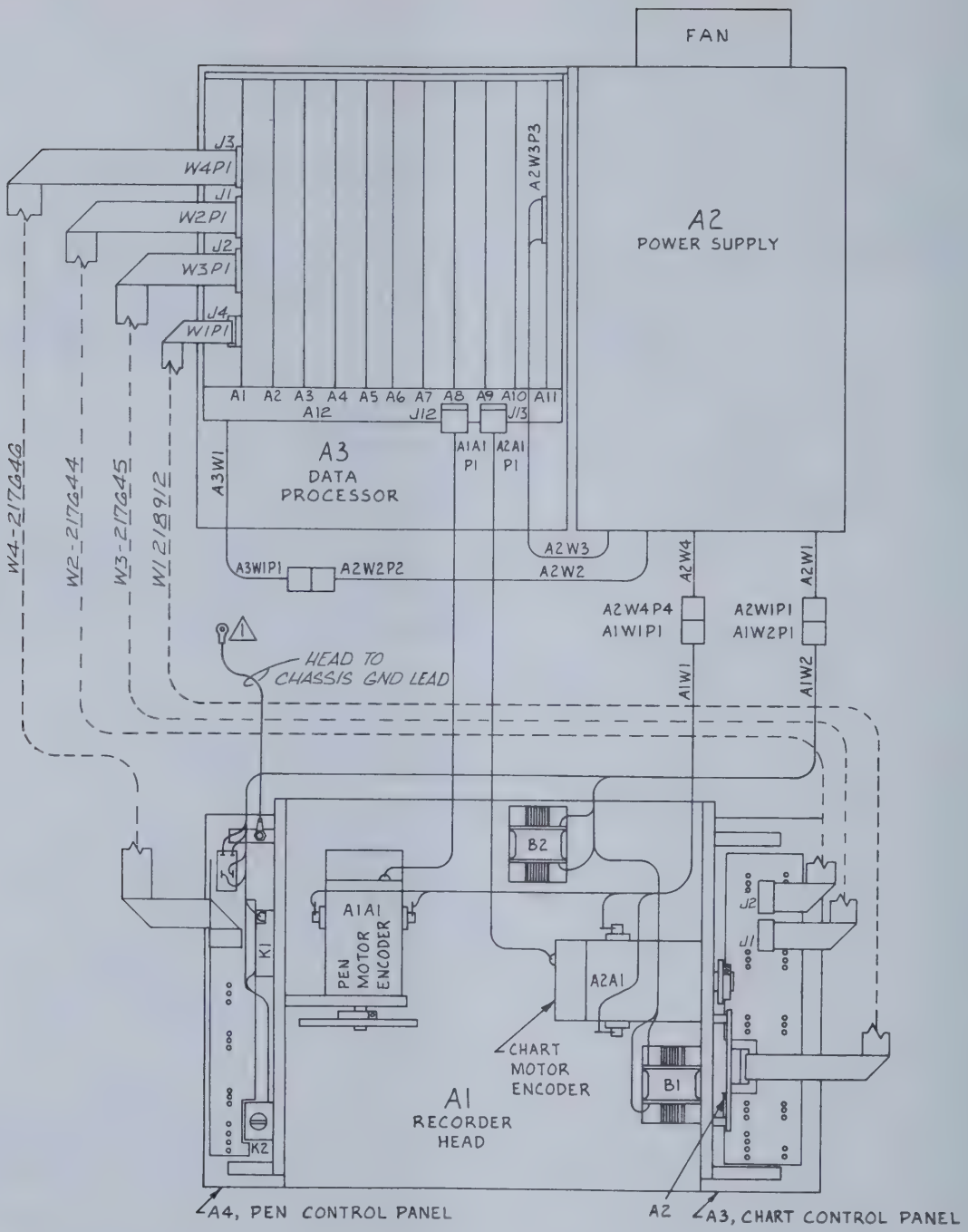


Figure 7-1. Figure Reference Index Using a Drawing Tree Arrangement



NOTES:

⚠ GND LEAD TO BE TERMINATED AT HEAD FRAME, USING ONE OF THE BOTTOM SCREWS MOUNTING THE FRONT PANEL, AND CHASSIS, USING ONE OF THE NO.6 SCREWS MOUNTING THE HEAD MOUNTING BRACKET. GND LEAD TO BE 6 IN. LONG, NO.20 AWG STRANDED, GREEN INSULATED WIRE WITH A NO.6 GND LUG TERMINAL SOLDERED AT EACH END.

Figure 7-3. Intercabling Identification

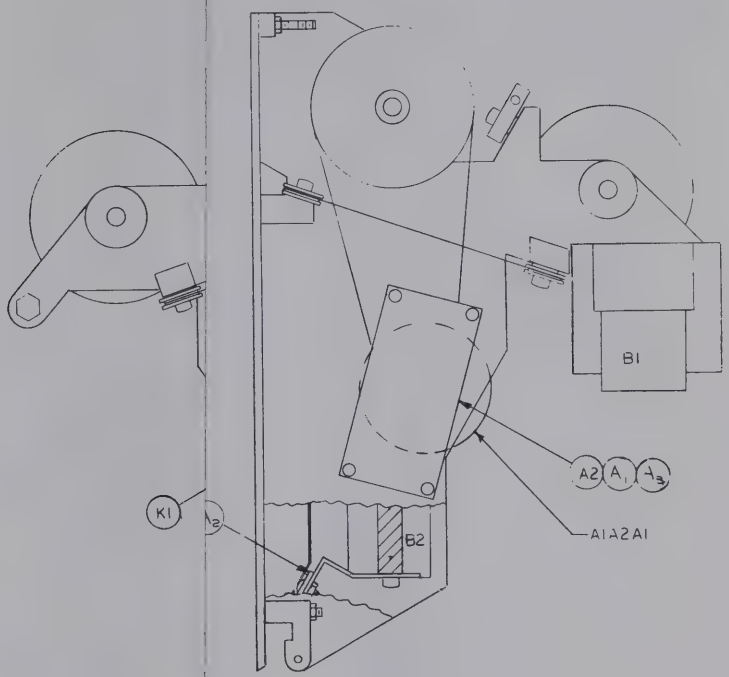
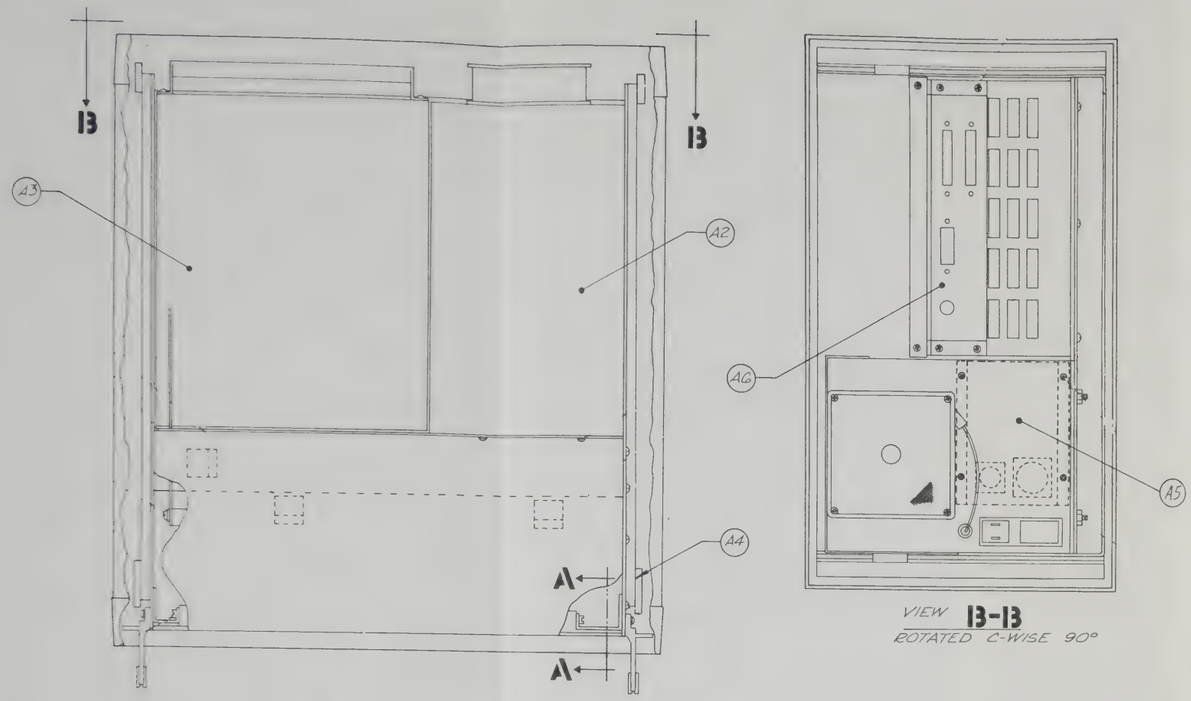
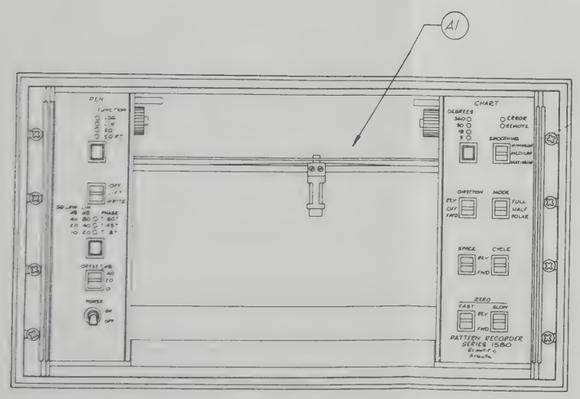


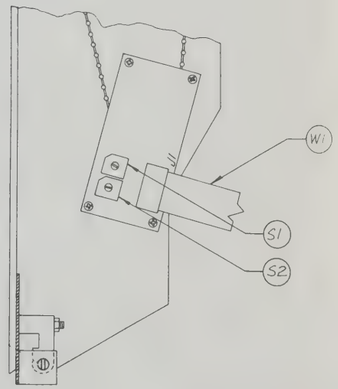
Figure 7-4. Recorder Head Assembly (A1), Outline Drawing



VIEW **B-B**
ROTATED C-WISE 90°



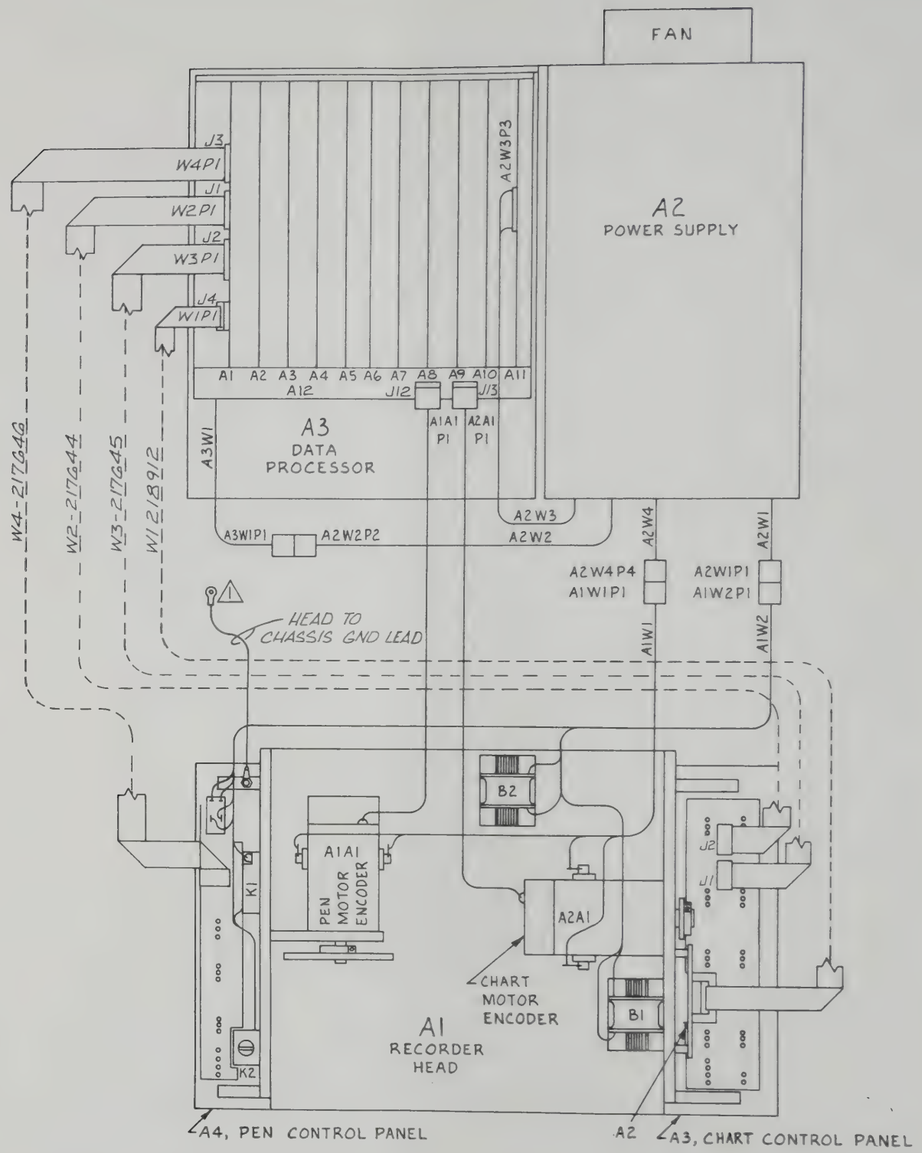
SCALE (1/2)



DETAIL **A-A**
SCALE (1:1)

NOTE:
A5 IS OPTIONAL.

Figure 7-2. General Assembly Outline



NOTES:

1. GND LEAD TO BE TERMINATED AT HEAD FRAME, USING ONE OF THE BOTTOM SCREWS MOUNTING THE FRONT PANEL, AND CHASSIS, USING ONE OF THE NO.6 SCREWS MOUNTING THE HEAD MOUNTING BRACKET. GND LEAD TO BE 6 IN. LONG, NO.20 AWG STRANDED, GREEN INSULATED WIRE WITH A NO.6 GND LUG TERMINAL SOLDERED AT EACH END.

Figure 7-3. Intercabling Identification

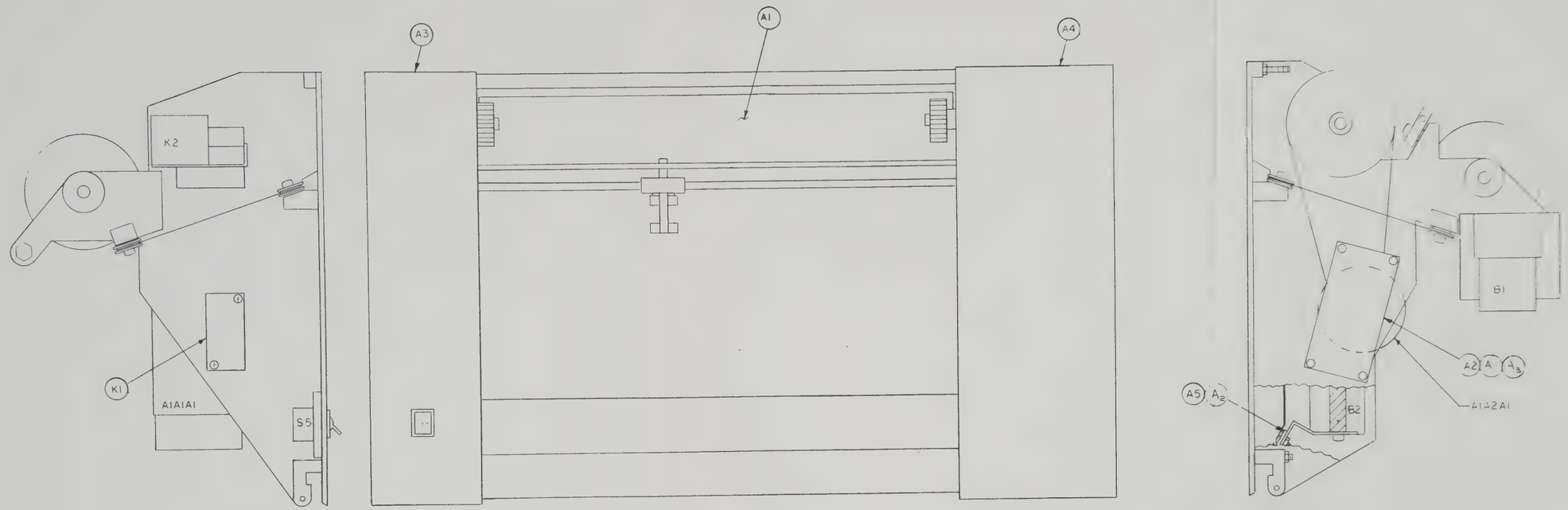


Figure 7-4. Recorder Head Assembly (A1), Outline Drawing

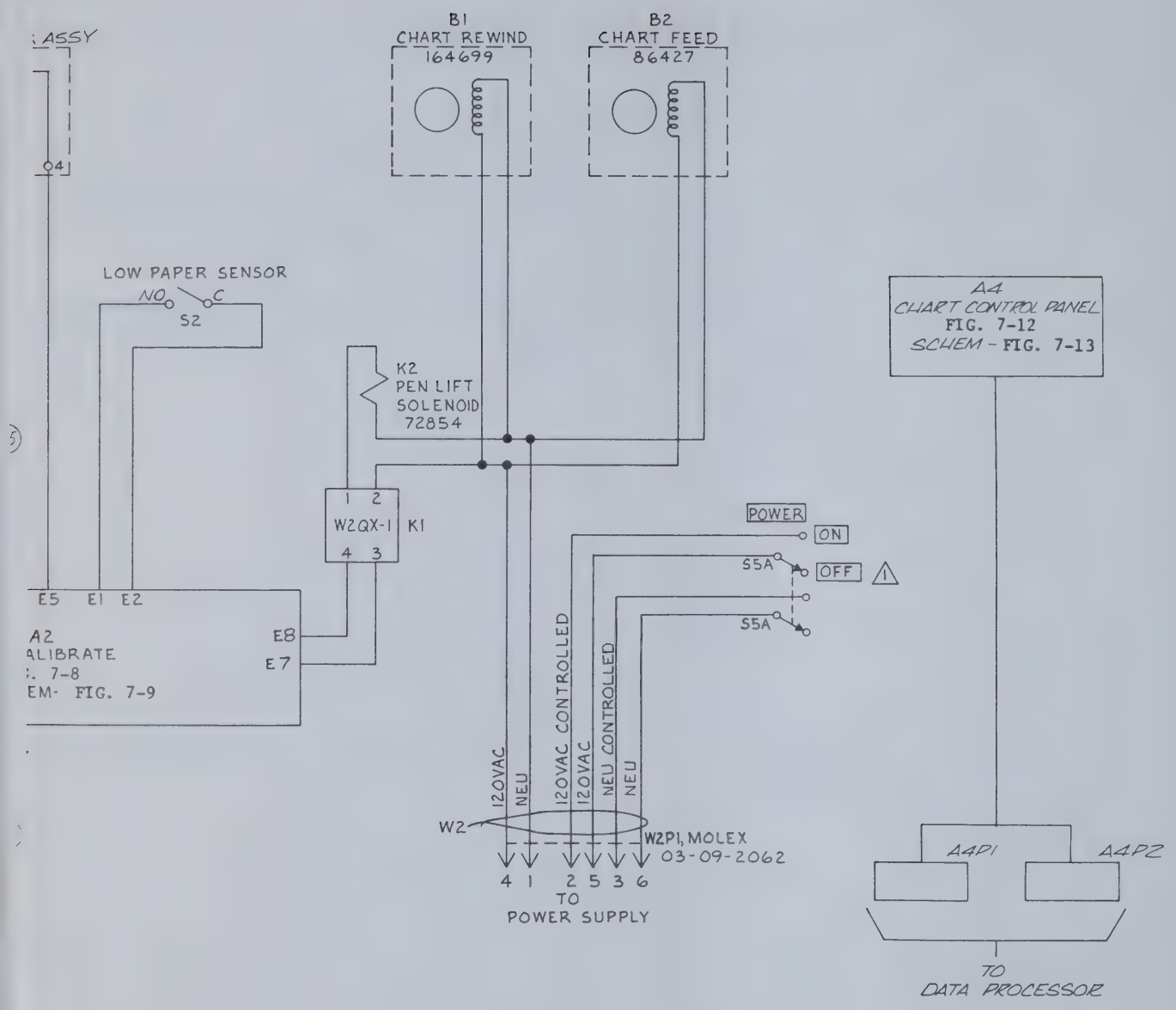
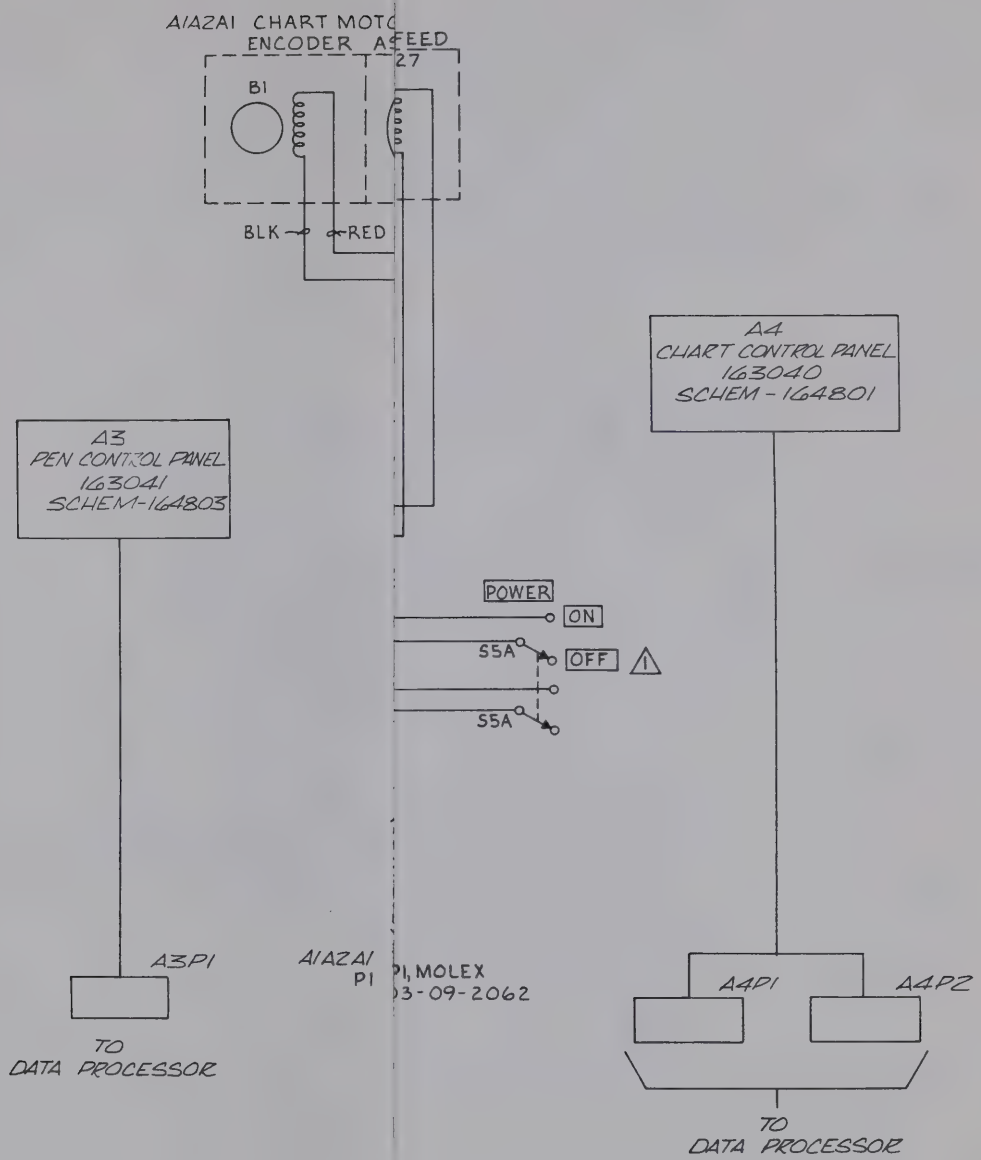


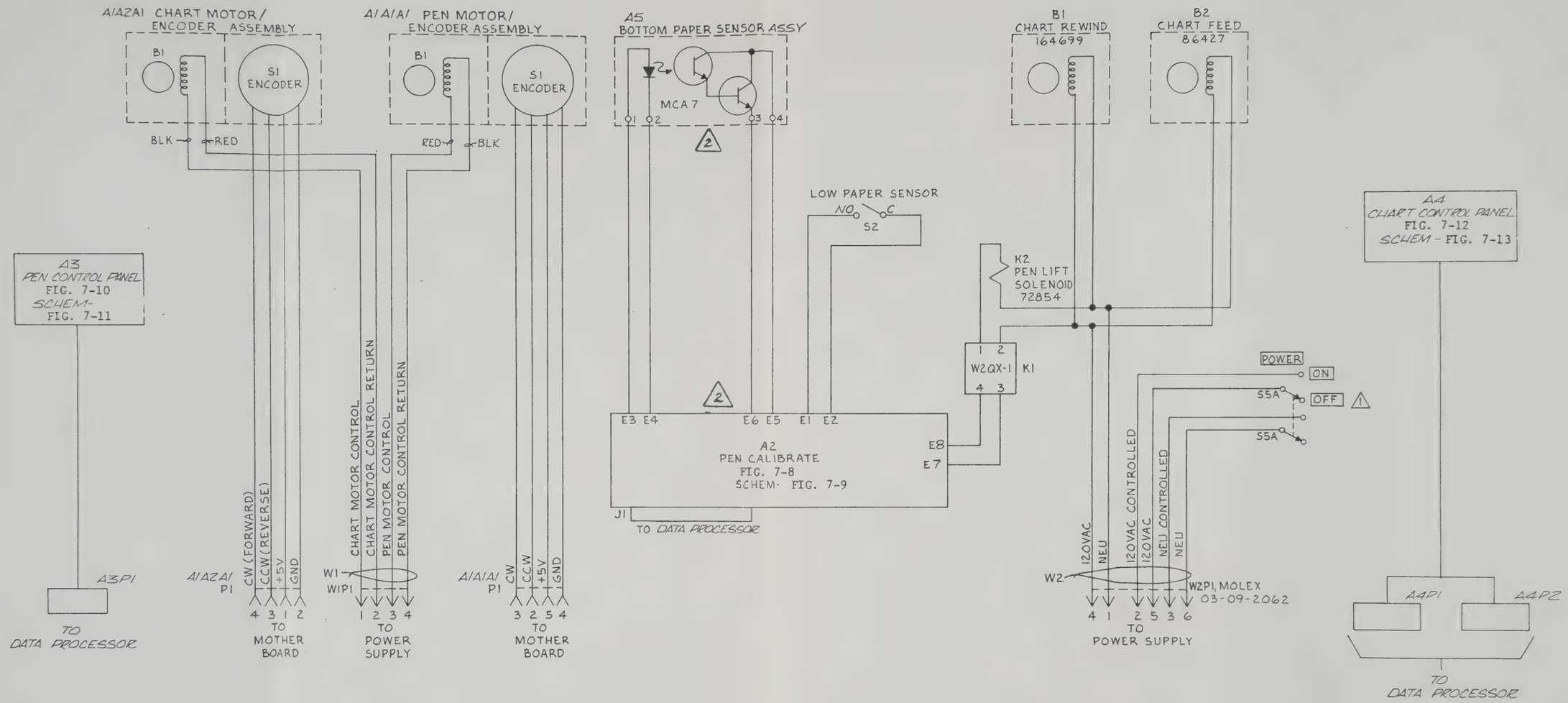
Figure 7-5. Recorder Head Assembly (A1), Schematic



NOTES:

1. POWER SWITC
2. WIRING CONF
   (SEE FIGURE
3. FUSE W1F1 L
   ASSEMBLY.
   (APPROXIMAT

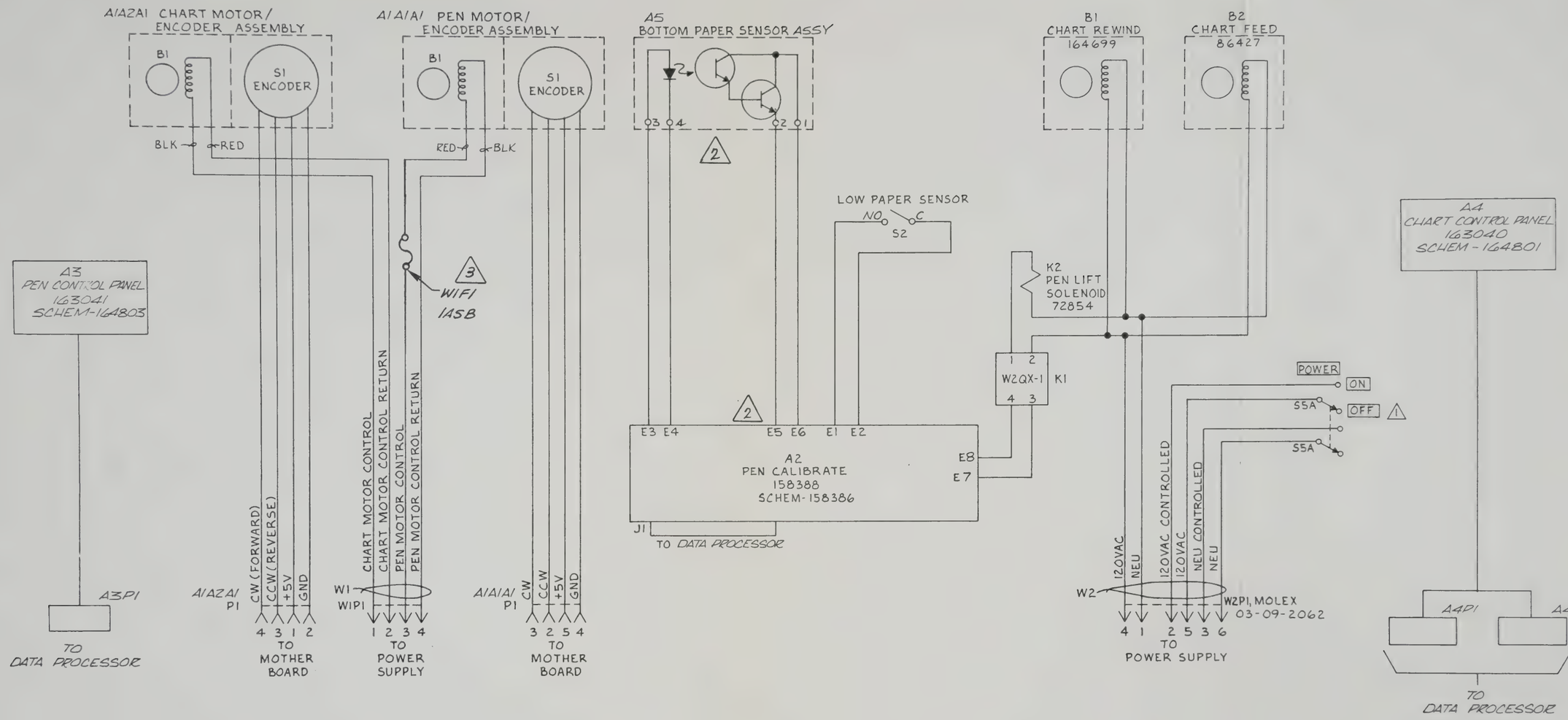
Figure 7-5a. Recorder Head Assembly (A1), Schematic



NOTES

1. POWER SWITCH S5 LOCATED ON PEN CONTROL PANEL A3.
2. WIRING CONFIGURATION MAY VARY WITH DIFFERENT UNITS. (SEE FIGURE 7-5A FOR OTHER CONFIGURATION.)

Figure 7-5. Recorder Head Assembly (A1), Schematic



NOTES:

1. POWER SWITCH S5 LOCATED ON PEN CONTROL PANEL A3.
2. WIRING CONFIGURATION MAY VARY WITH DIFFERENT UNITS. (SEE FIGURE 7-5 FOR OTHER CONFIGURATION.)
3. FUSE W1F1 LOCATED ON FRAME SUPPORT BRACKET OF FRAME ASSEMBLY. APPLIES TO SERIAL NUMBER 536 AND ABOVE (APPROXIMATELY).

Figure 7-5a. Recorder Head Assembly (A1), Schematic

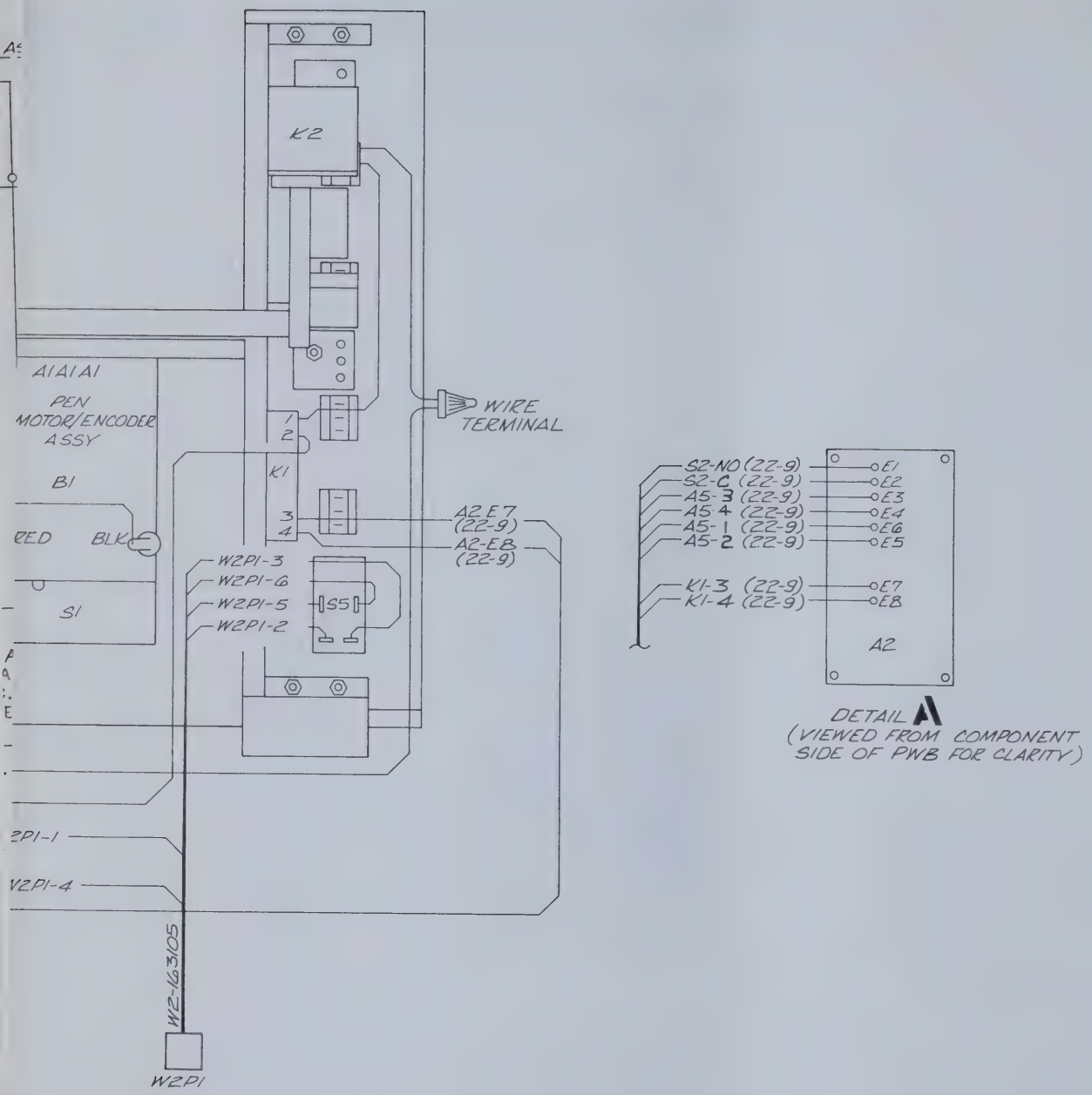
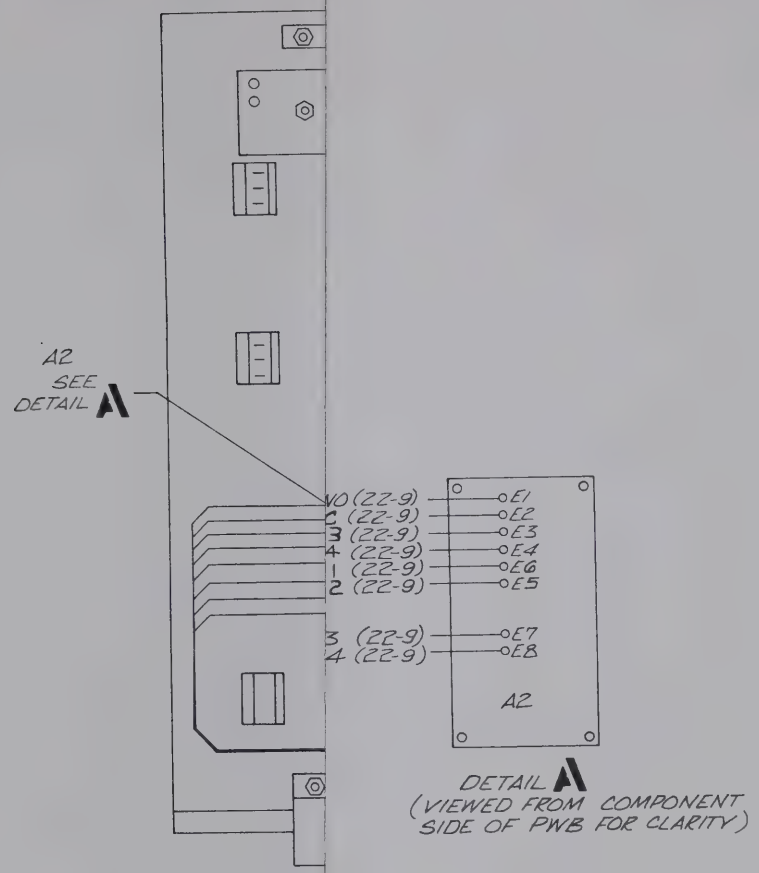


Figure 7-6. Recorder Head Assembly (A1), Wiring and Cable Diagram



NOTE:
1. APPLIES TO SERI
(APPROXIMATELY)

Figure 7-6a. Recorder Head Assembly (A1), Wiring and Cable Diagram

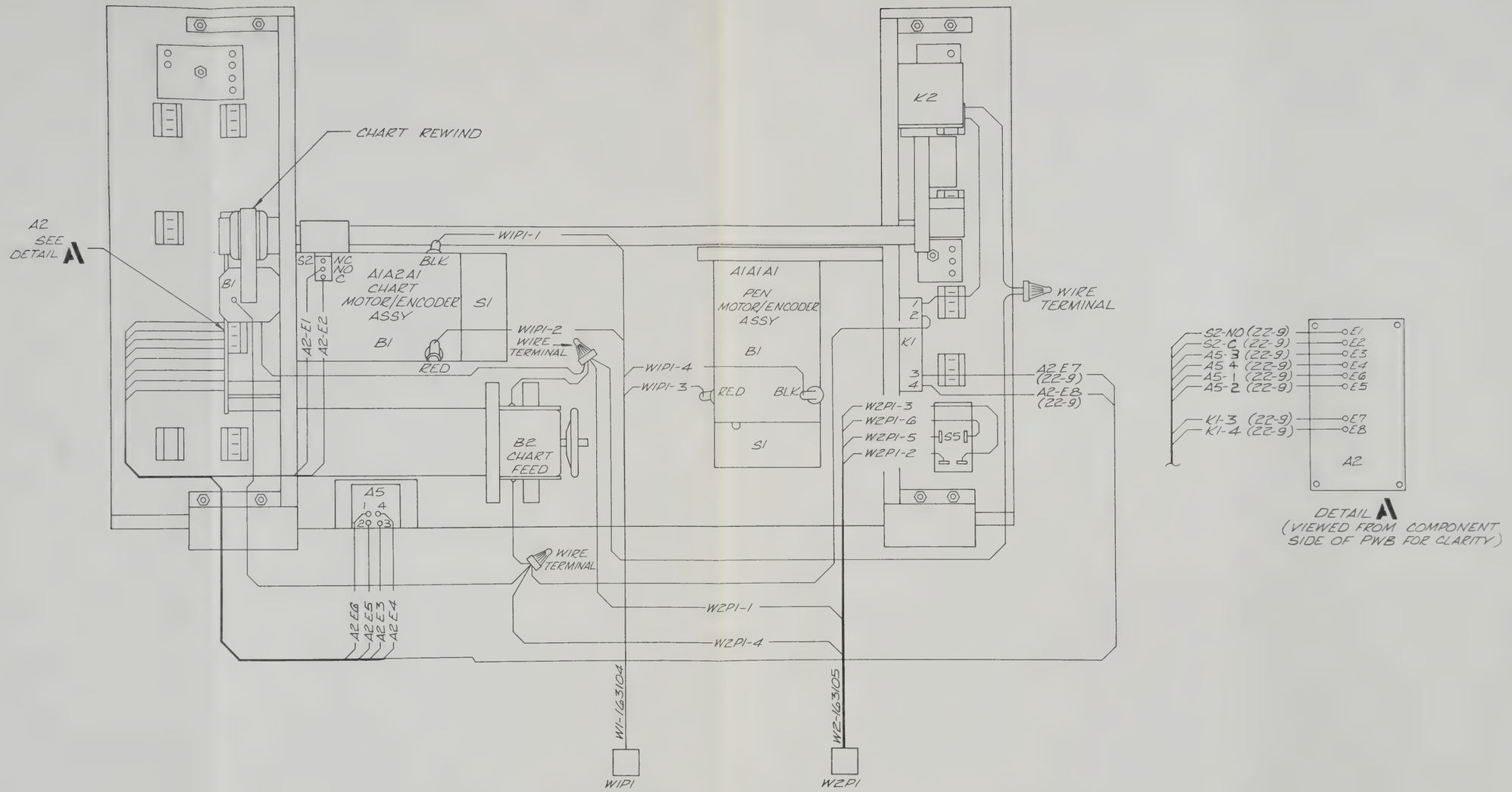
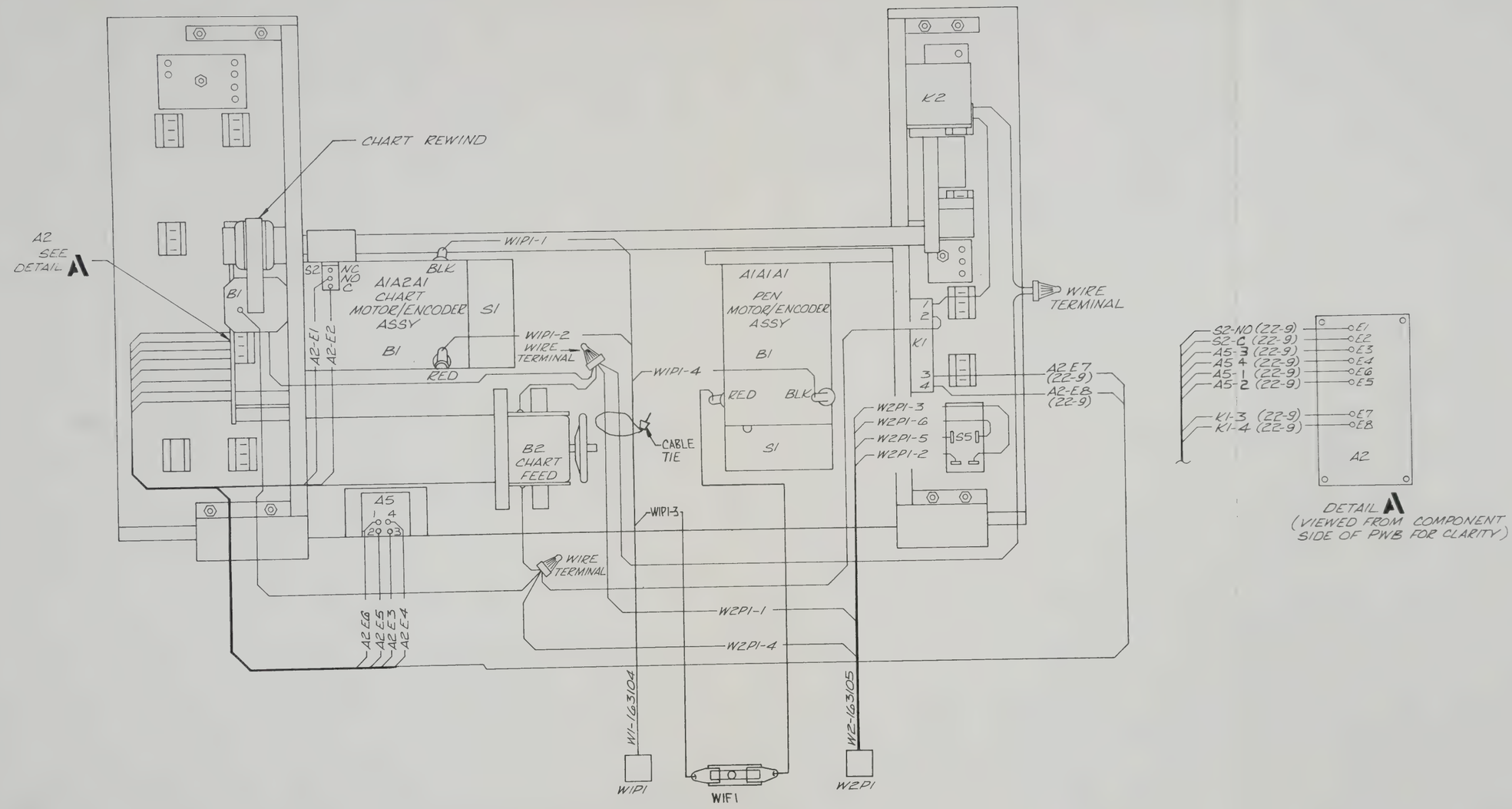


Figure 7-6. Recorder Head Assembly (A1), Wiring and Cable Diagram



NOTE:
1. APPLIES TO SERIAL NUMBER 536 AND ABOVE (APPROXIMATELY).

Figure 7-6a. Recorder Head Assembly (A1), Wiring and Cable Diagram

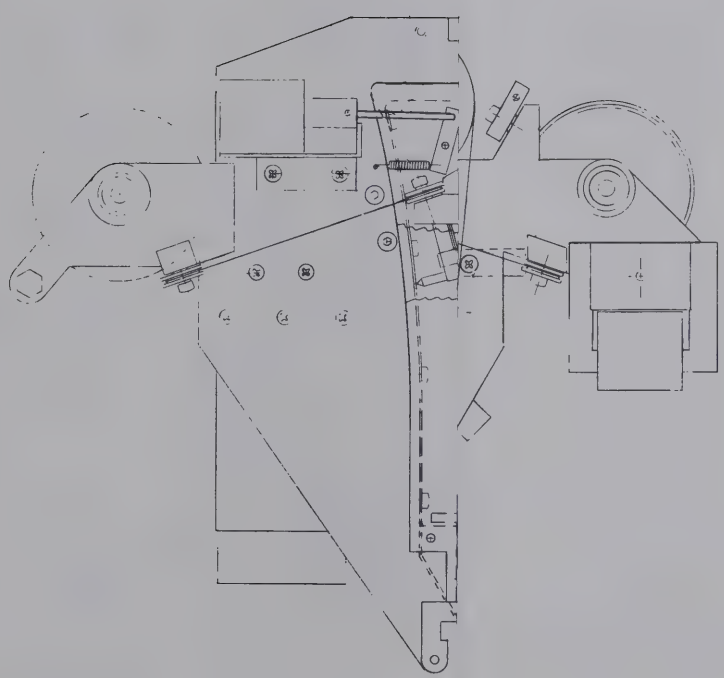
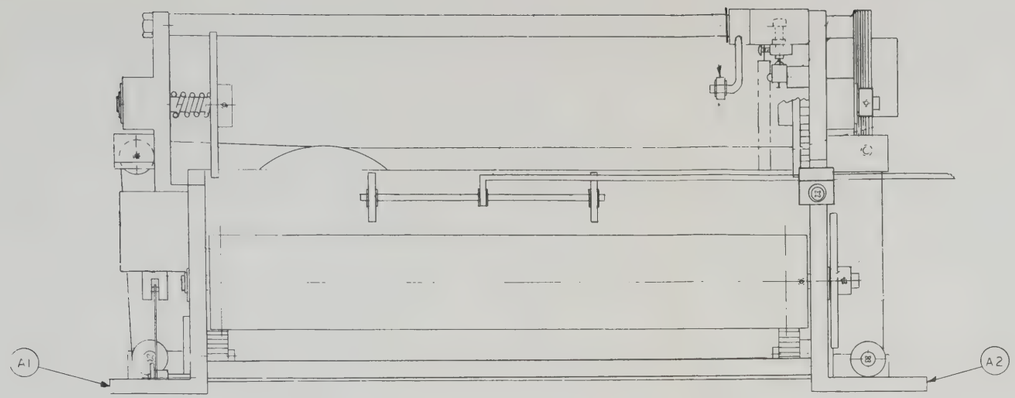
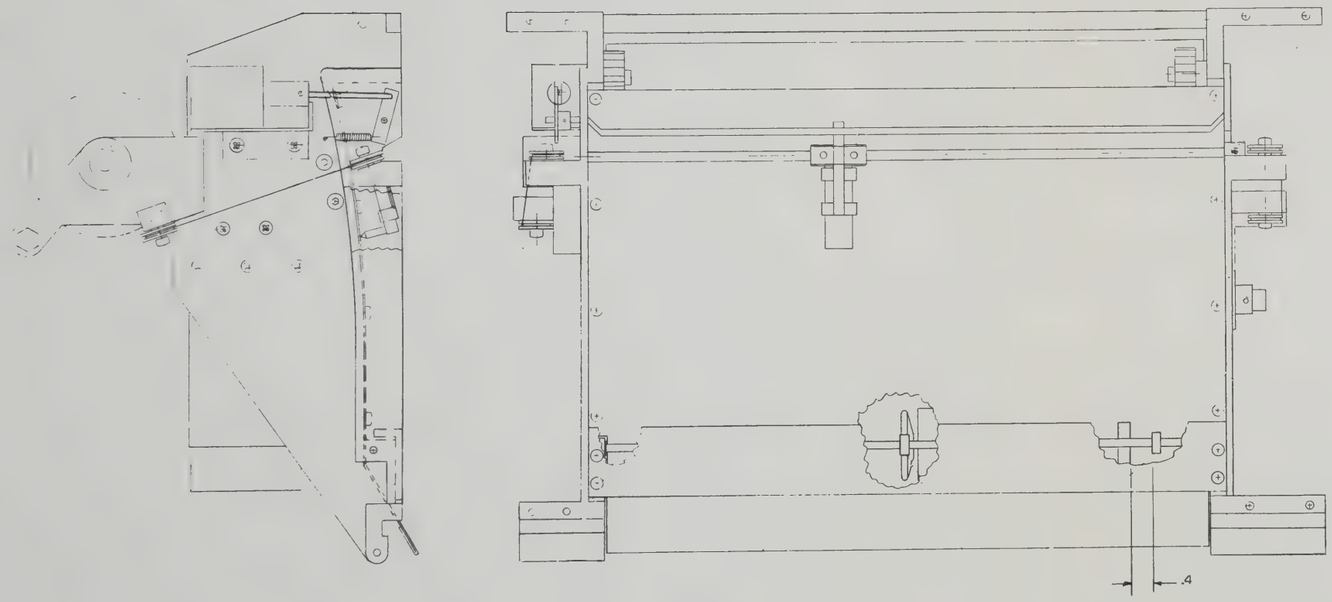


Figure 7-7. Recording Head Subassembly (A1A1), Component Location





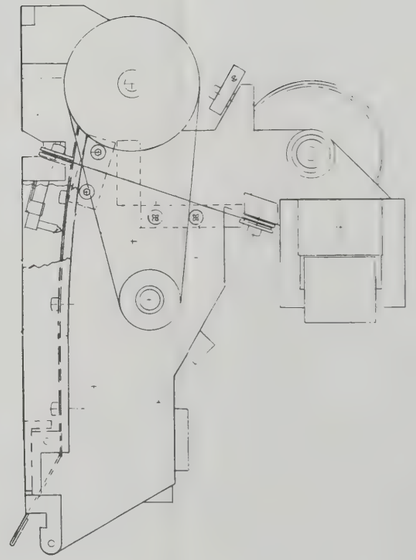
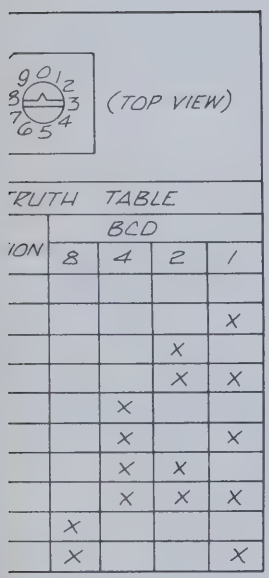


Figure 7-7. Recording Head Subassembly (A1A1), Component Location



TRUTH TABLE				
	BCD			
	8	4	2	1
				X
			X	
			X	X
		X		
		X		X
		X	X	
		X	X	X
	X			
	X			X

: TO PEN LIFT SOLENOID.

CO SERIES 2300-02-G MICRODIP.
BOTTOM OF SWITCHES
14 PIN DIP SOCKET.
M EDGE SENSOR
MCA7
MCA7
, MCA7
MCA7

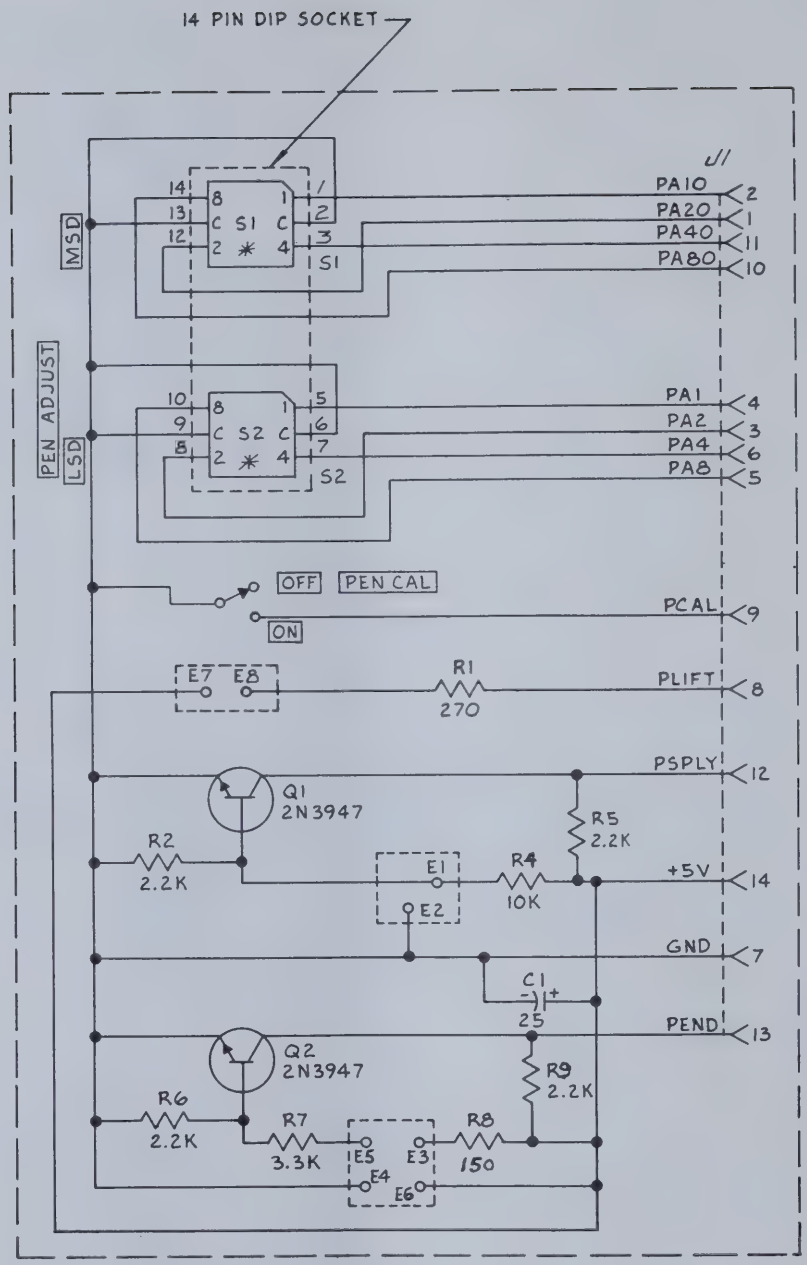
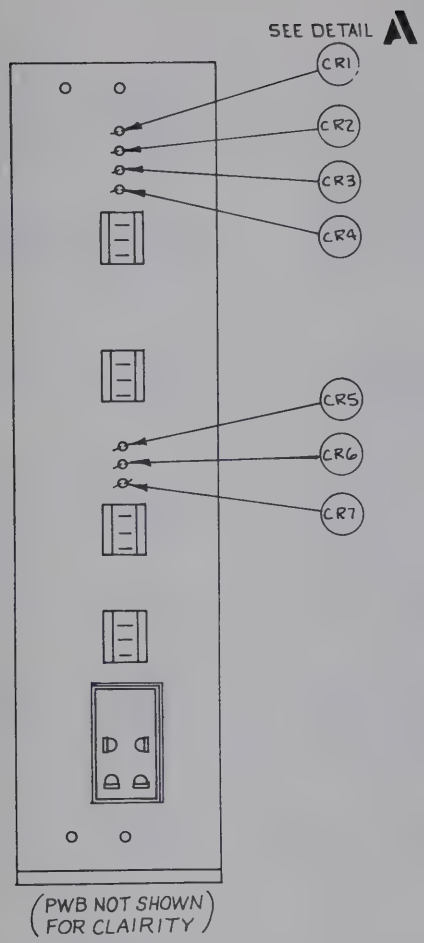


Figure 7-9. Pen Calibrate Printed Circuit Board (A1A1A2), Schematic

158386A



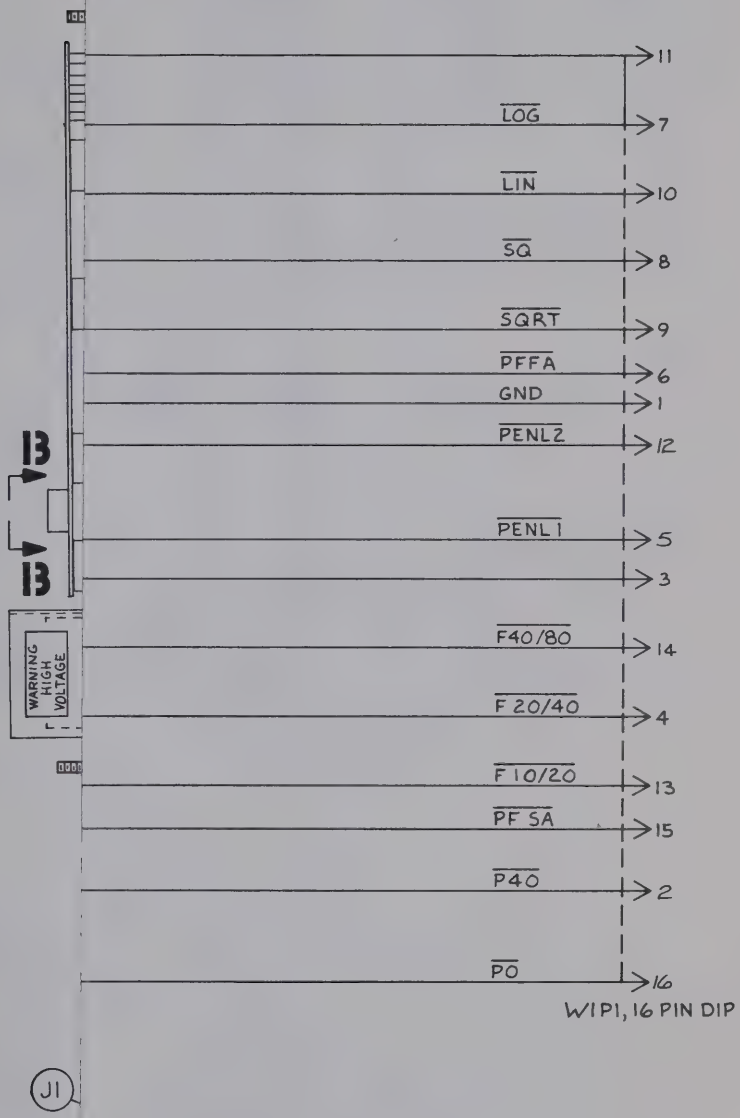


Figure 7-10. Pen Control Panel (A1 Component Location

Figure 7-11. Pen Control Panel (A1A1A3), Schematic

163041A

164803A

41R038E

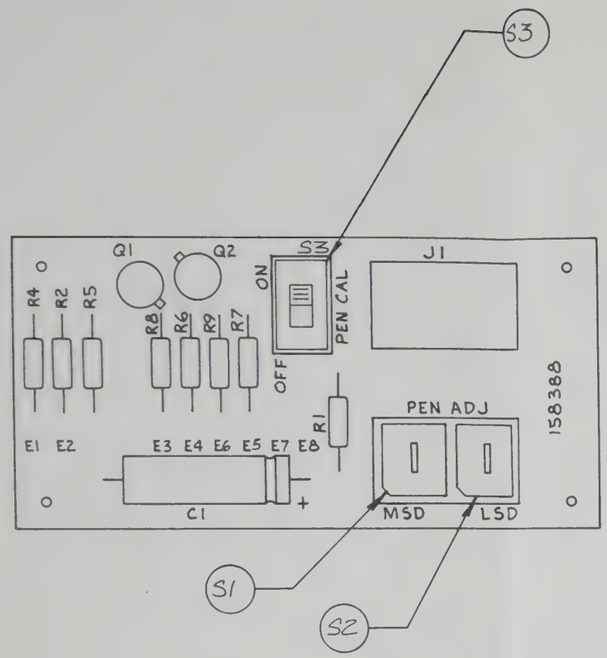


Figure 7-8. Pen Calibrate Printed Circuit Board (A1A1A2), Component Location

158388A

41R038E

*

TRUTH TABLE				
POSITION	BCD 8	4	2	1
0				
1				X
2			X	
3			X	X
4		X		
5		X		X
6		X	X	
7		X	X	X
8	X			
9	X			X

NOTES:
1. E7 & E8 DRIVE TO PEN LIFT SOLENOID.
2. S1 AND S2, EECO SERIES 2300-02-G MICRODIP. VIEW SHOWS BOTTOM OF SWITCHES INSTALLED IN 14 PIN DIP SOCKET.
3. PAPER BOTTOM EDGE SENSOR
   E3 TO PIN 1 MCA7
   E4 TO PIN 2 MCA7
   E5 TO PIN 3 MCA7
   E6 TO PIN 4 MCA7

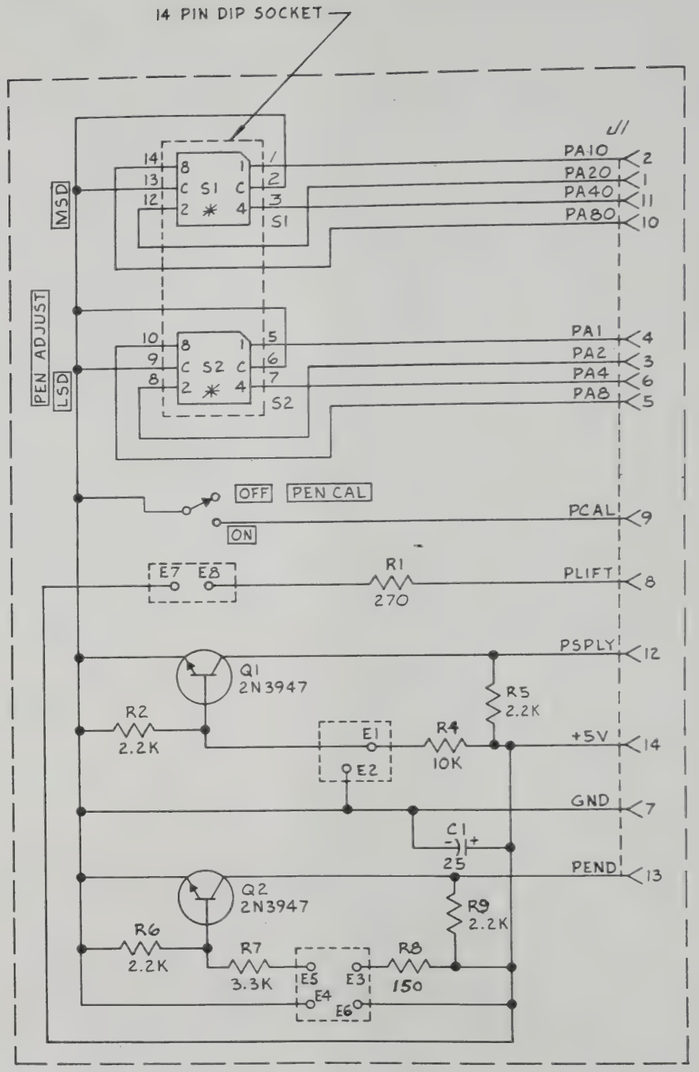


Figure 7-9. Pen Calibrate Printed Circuit Board (A1A1A2), Schematic

158386A

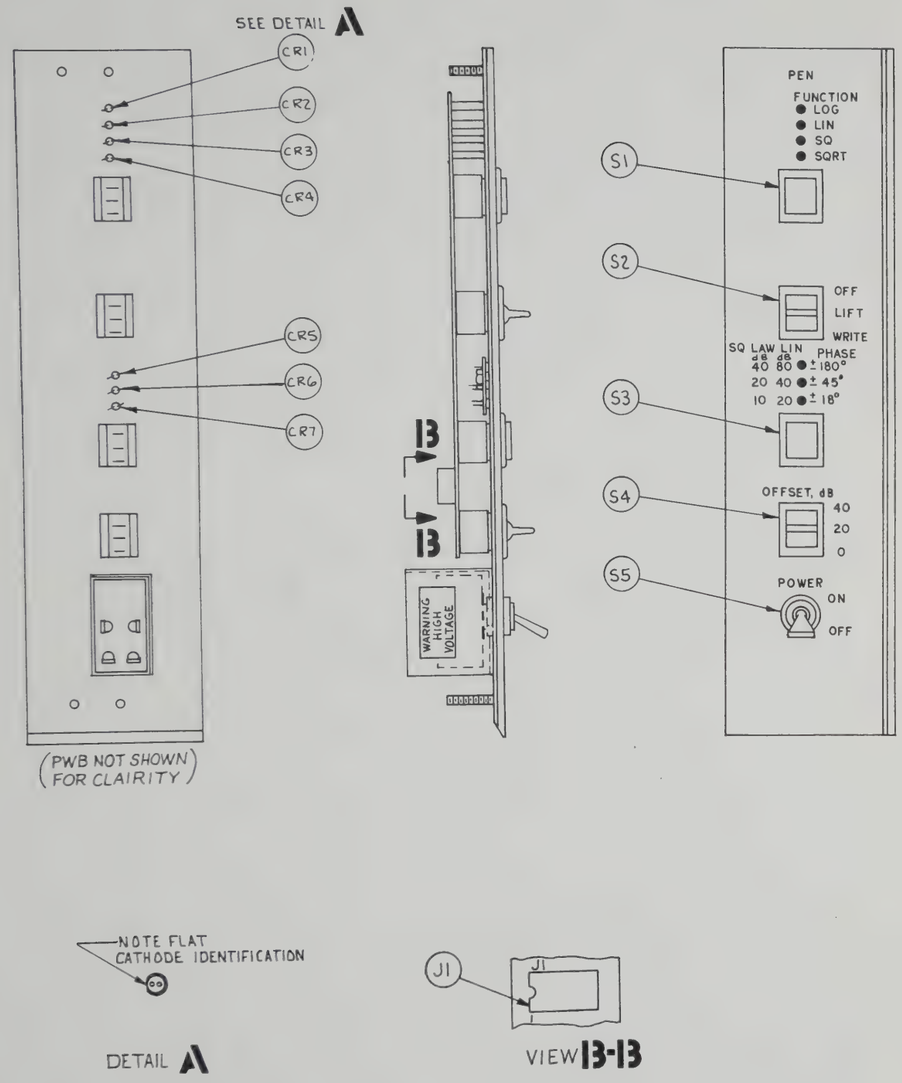


Figure 7-10. Pen Control Panel (A1A1A3), Component Location

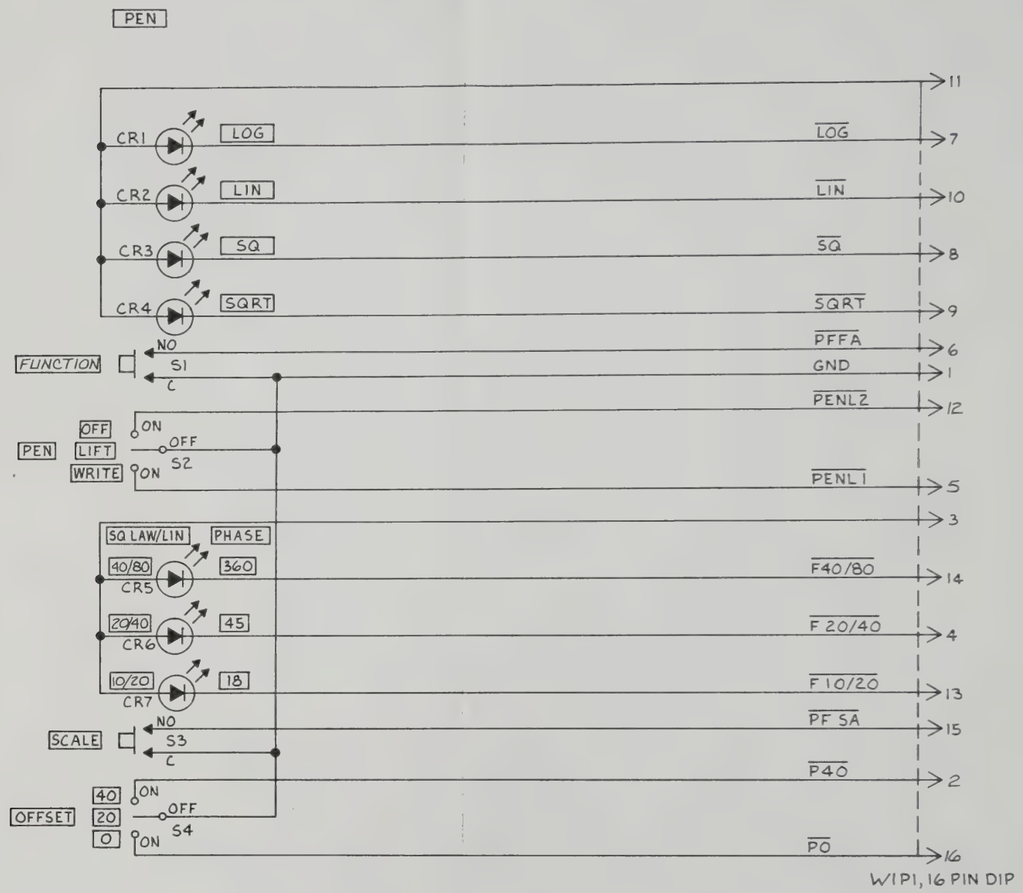


Figure 7-11. Pen Control Panel (A1A1A3), Schematic

163041A
41R038E

164803A

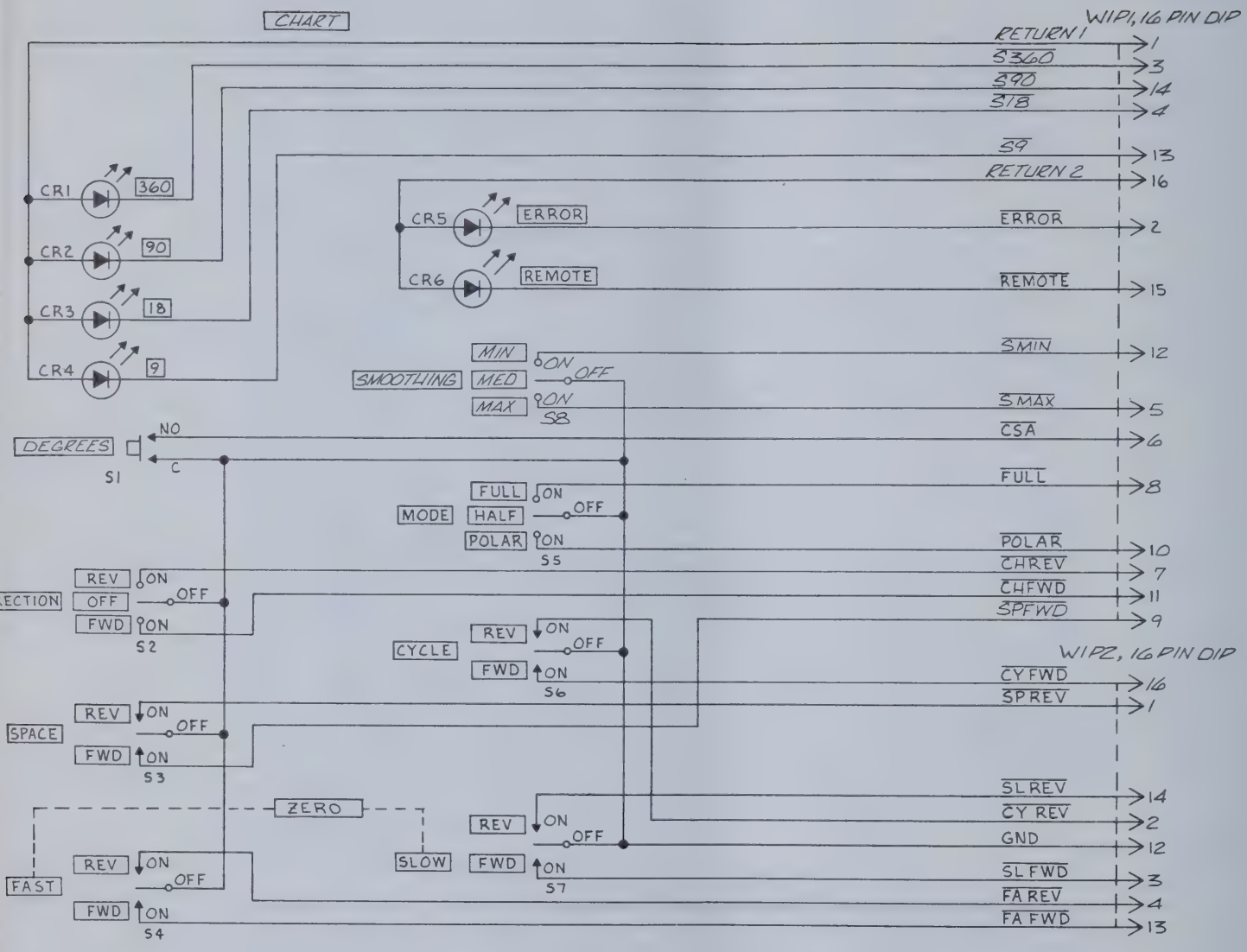
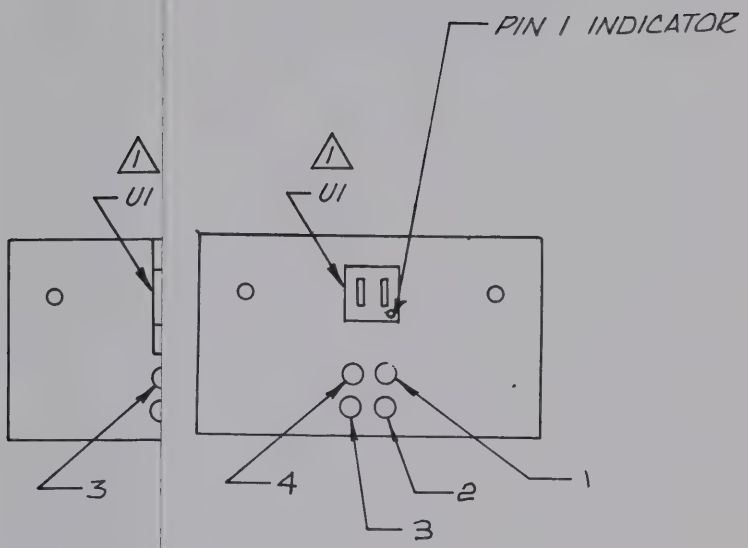


Figure 7-13. Chart Control Panel (A1A1A4), Schematic

164801A



NOTE:
1. REFERENCE DESIGNATION U1 & 1 THRU 4 ARE ON BACK OF BOARD.

ASSEMBLY MAY VARY Y MAY VARY WITH DIFFERENT UNITS.
(SEE FIGURE 7-14A GURE 7-14 FOR OTHER VARIATION.)

Figure 7-14. Bottom Paper Sensor (Component Location

Figure 7-14a. Bottom Paper Sensor (A1A1A5), Component Location

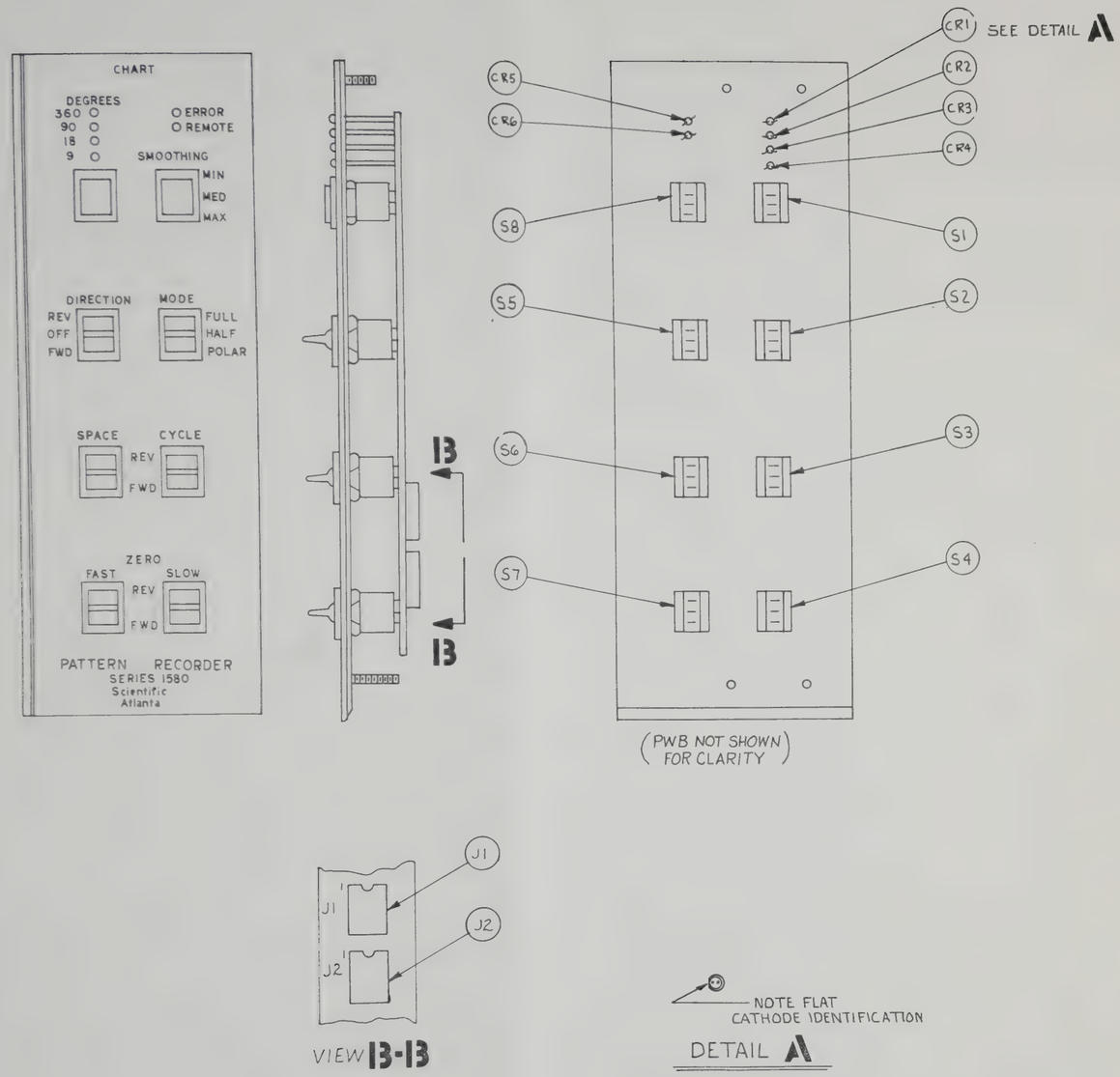


Figure 7-12. Chart Control Panel (A1A1A4), Component Location

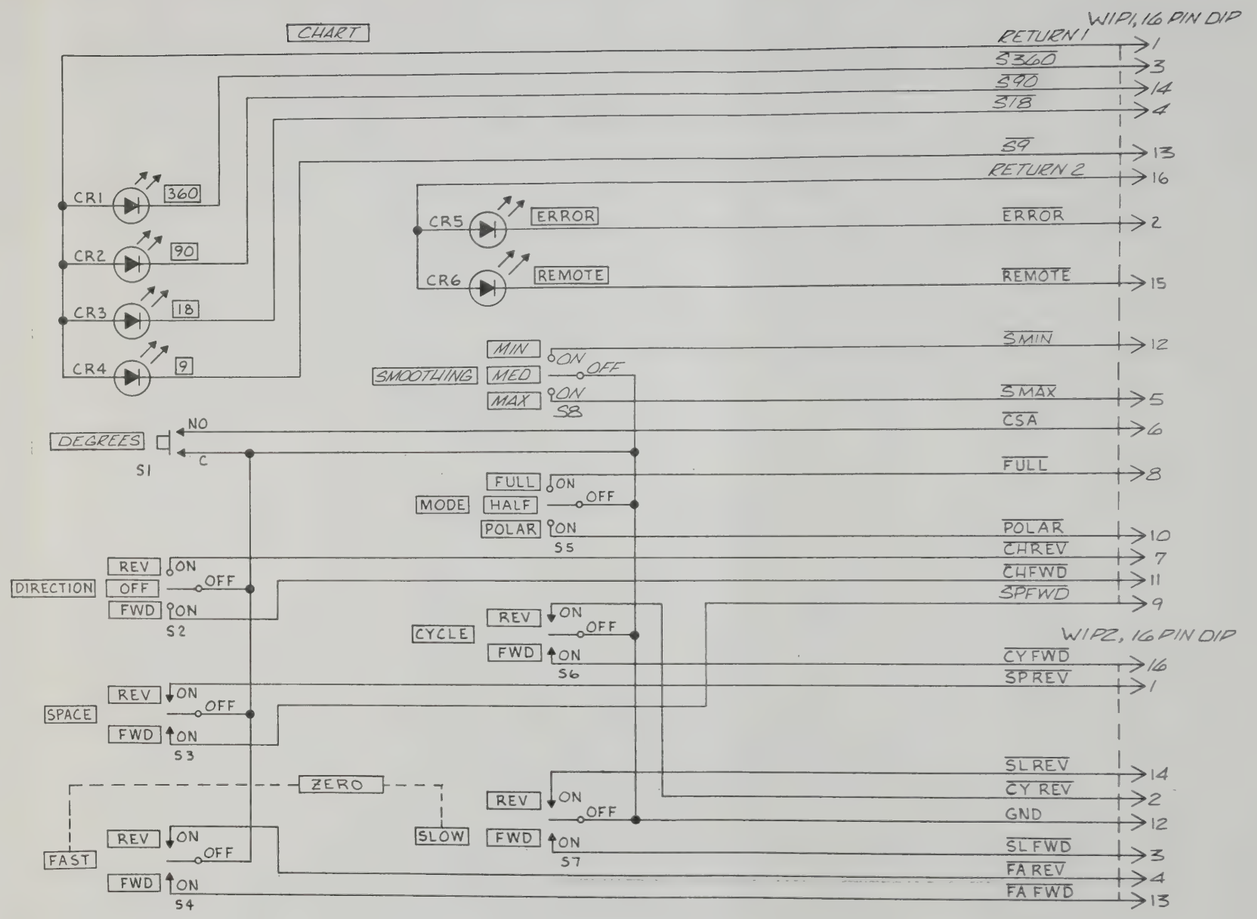
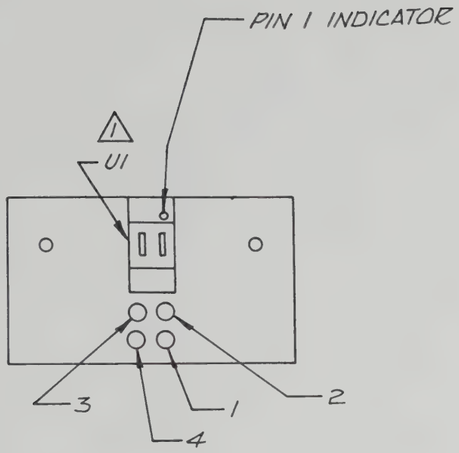


Figure 7-13. Chart Control Panel (A1A1A4), Schematic

163040A
41R038E

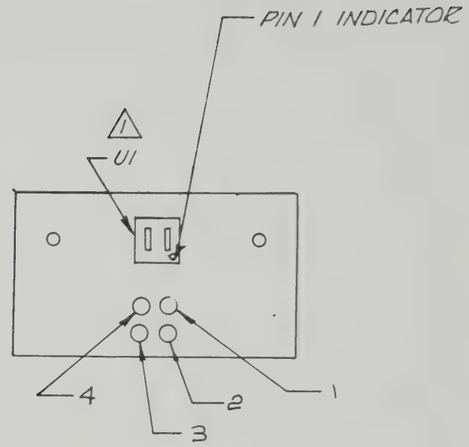
164801A



NOTE:
1. REFERENCE DESIGNATION U1 & 1 THRU 4 ARE ON BACK OF BOARD.

ASSEMBLY MAY VARY WITH DIFFERENT UNITS.
(SEE FIGURE 7-14A FOR OTHER VARIATION.)

Figure 7-14. Bottom Paper Sensor (A1A1A5), Component Location



NOTE:
1. REFERENCE DESIGNATION U1 & 1 THRU 4 ARE ON BACK OF BOARD.

ASSEMBLY MAY VARY WITH DIFFERENT UNITS.
(SEE FIGURE 7-14 FOR OTHER VARIATION.)

Figure 7-14a. Bottom Paper Sensor (A1A1A5), Component Location

SERIES 1580 PATTERN RECORDER, POWER SUPPLY ASSEMBLY (A2)

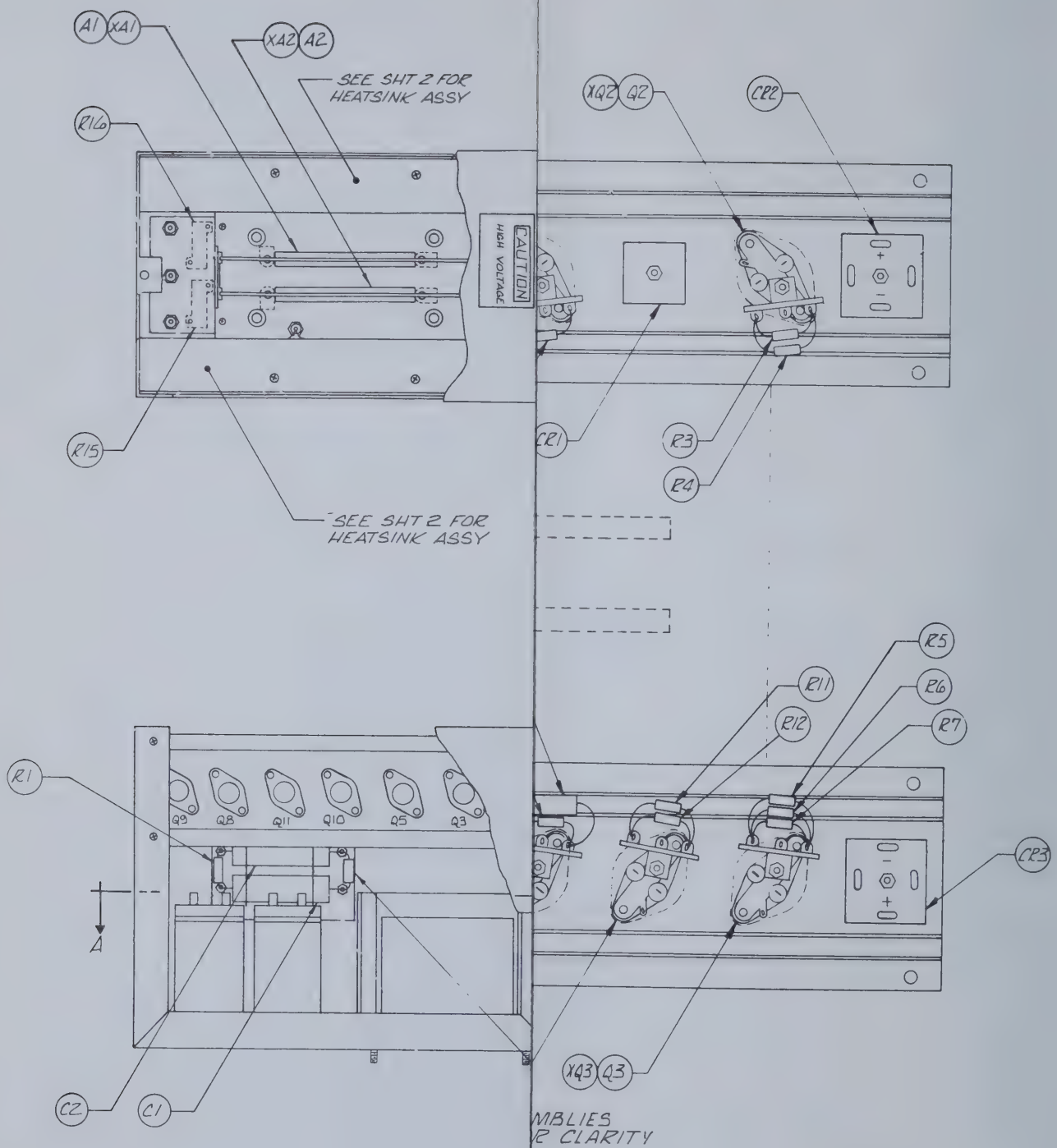


Figure 7-15. Power Supply Assembly (A2), Component Location

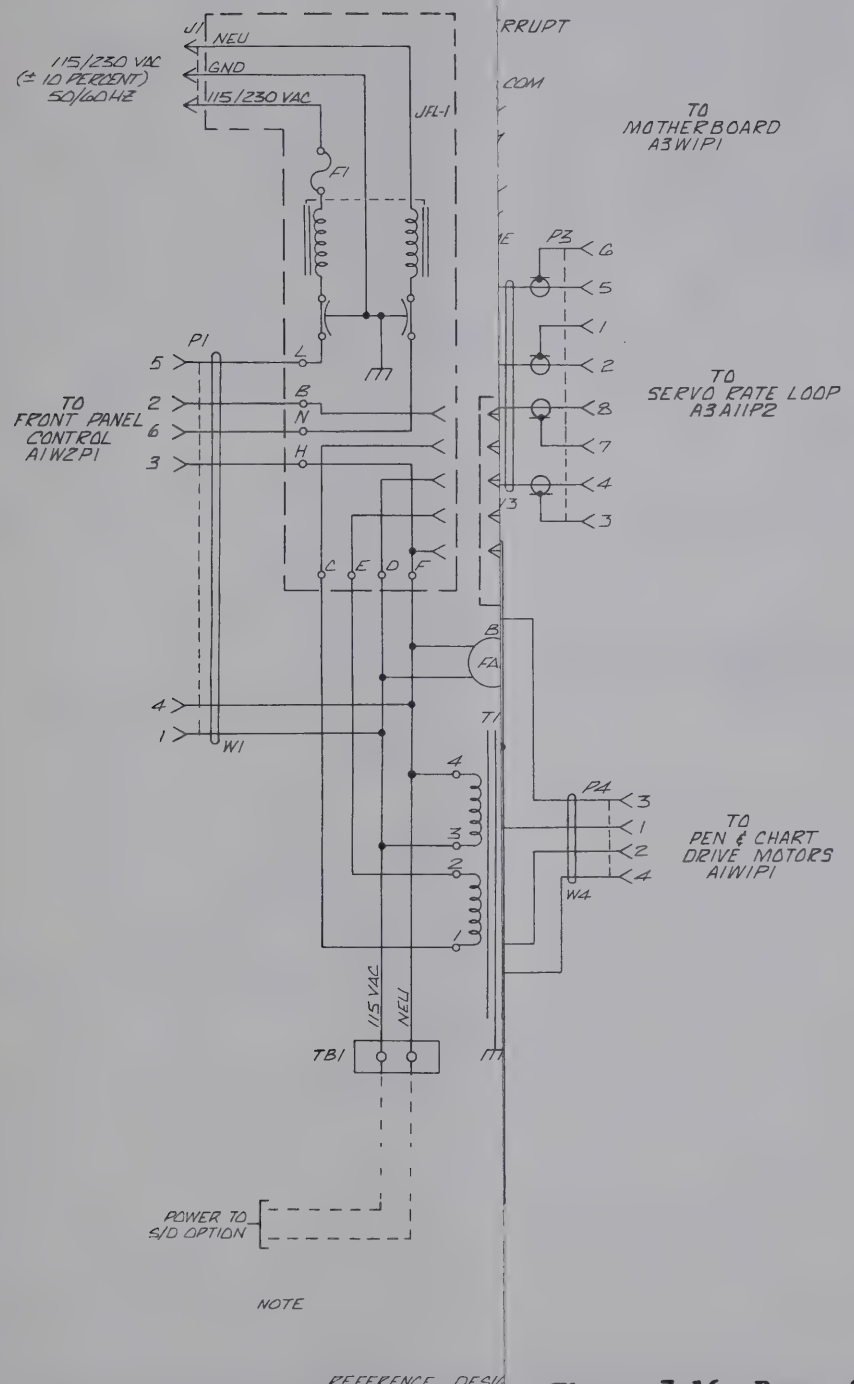
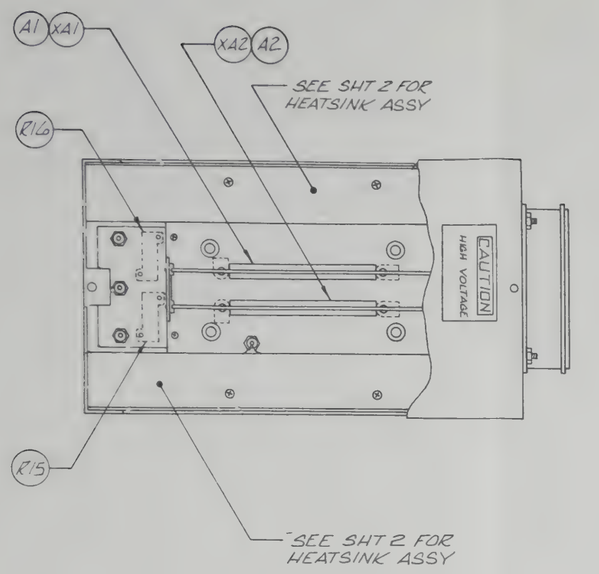
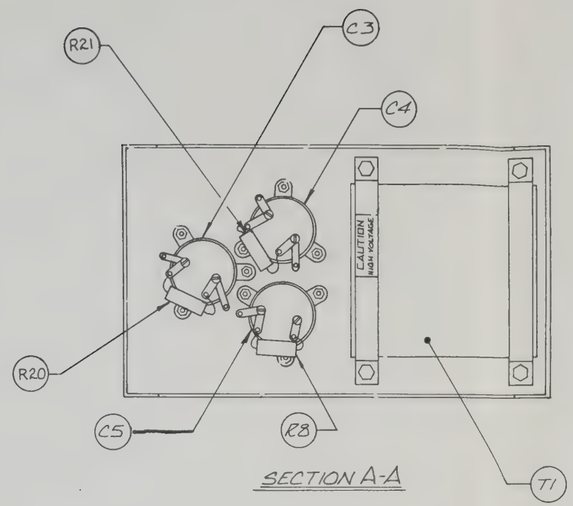
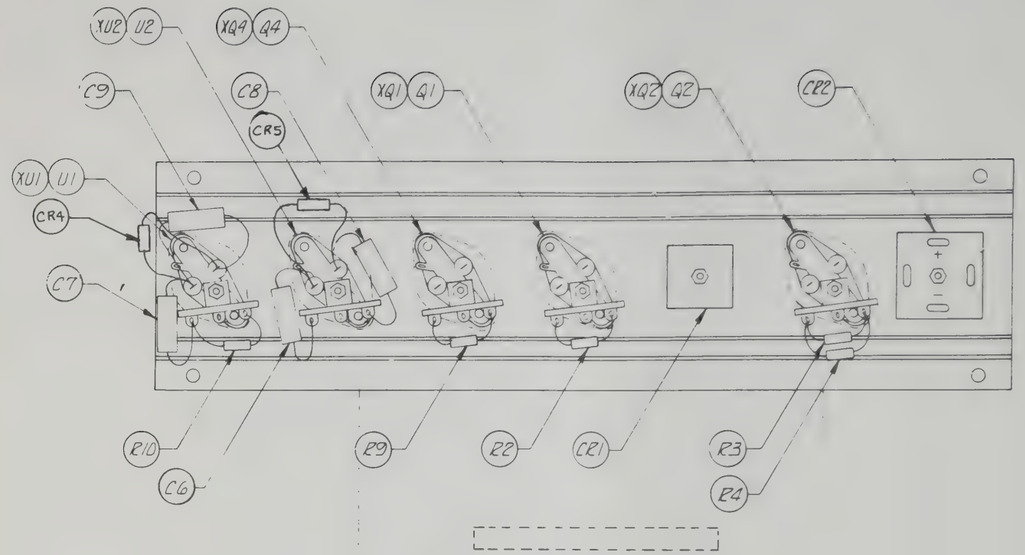


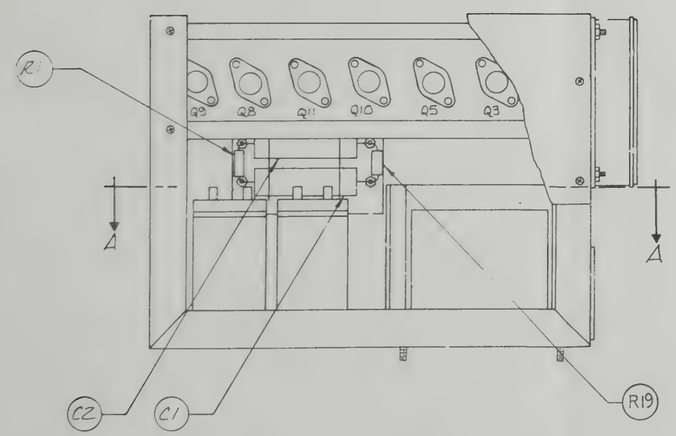
Figure 7-16. Power Supply Assembly (A2), Schematic



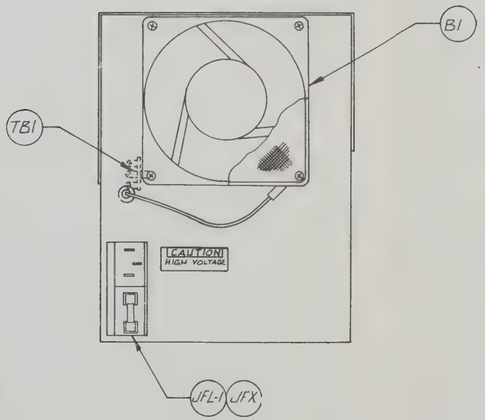


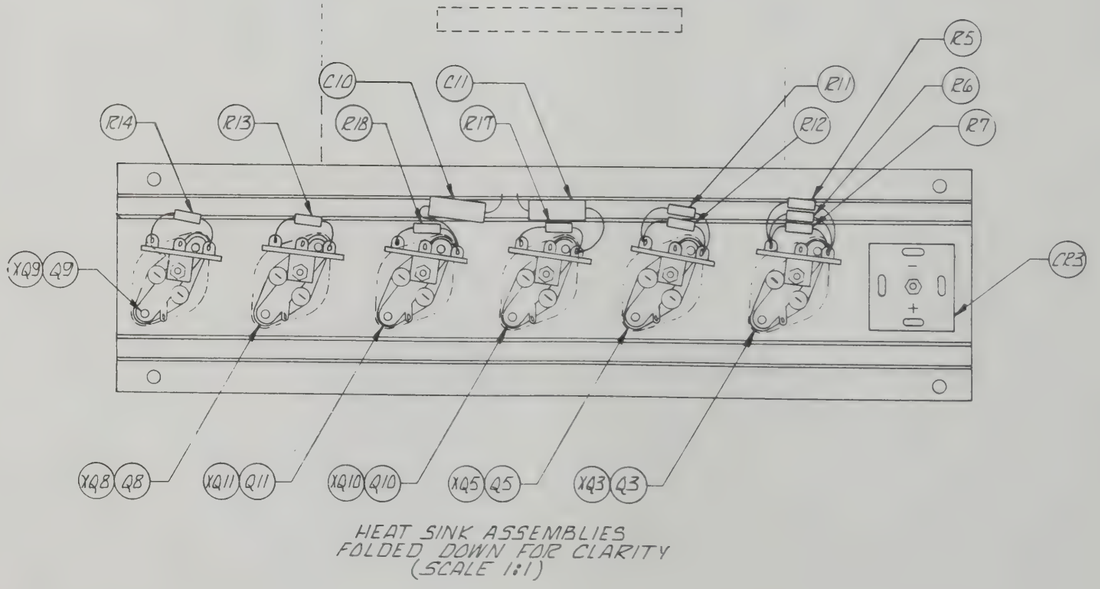
SECTION A-A





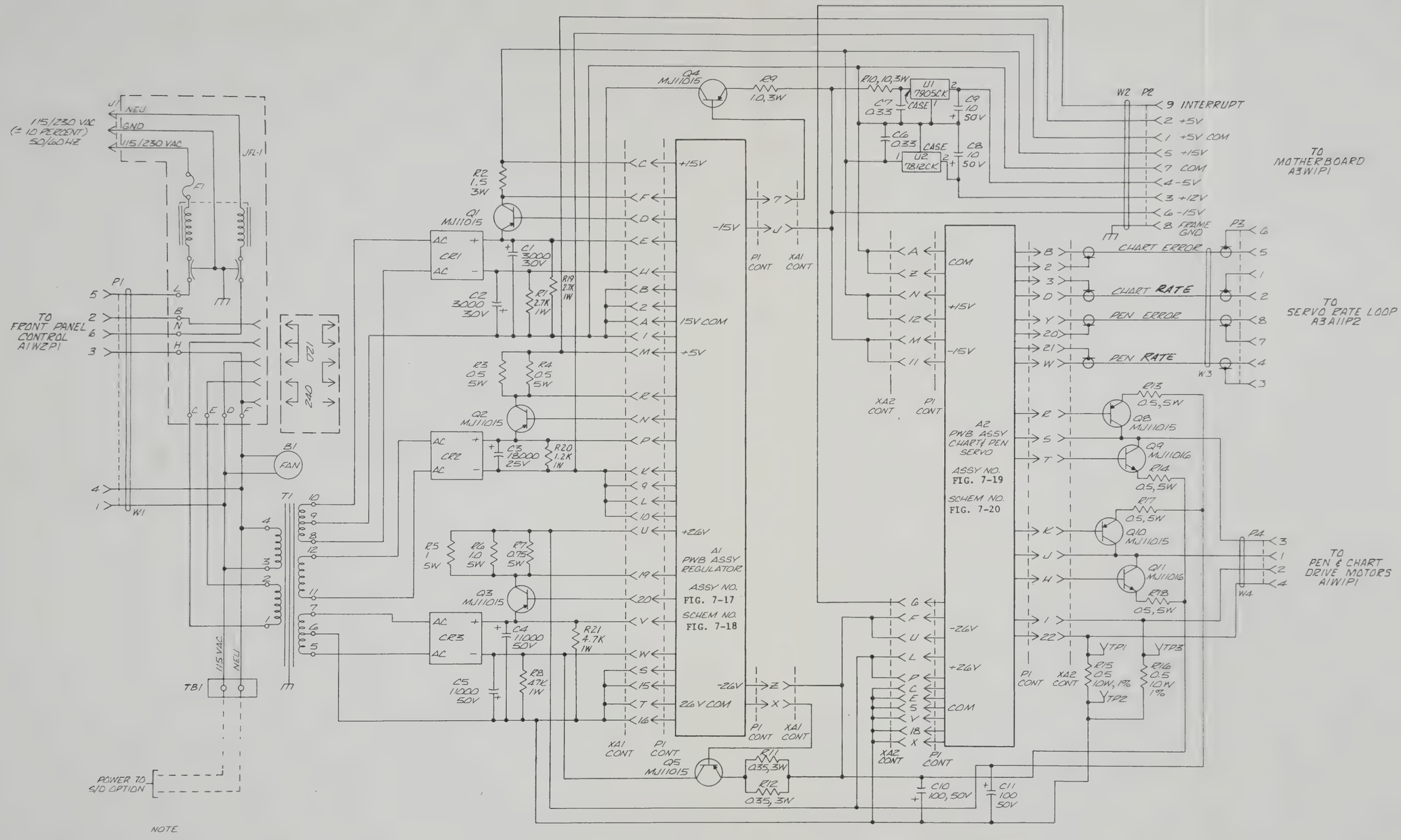
SCALE: 1/2





HEAT SINK ASSEMBLIES FOLDED DOWN FOR CLARITY (SCALE 1:1)

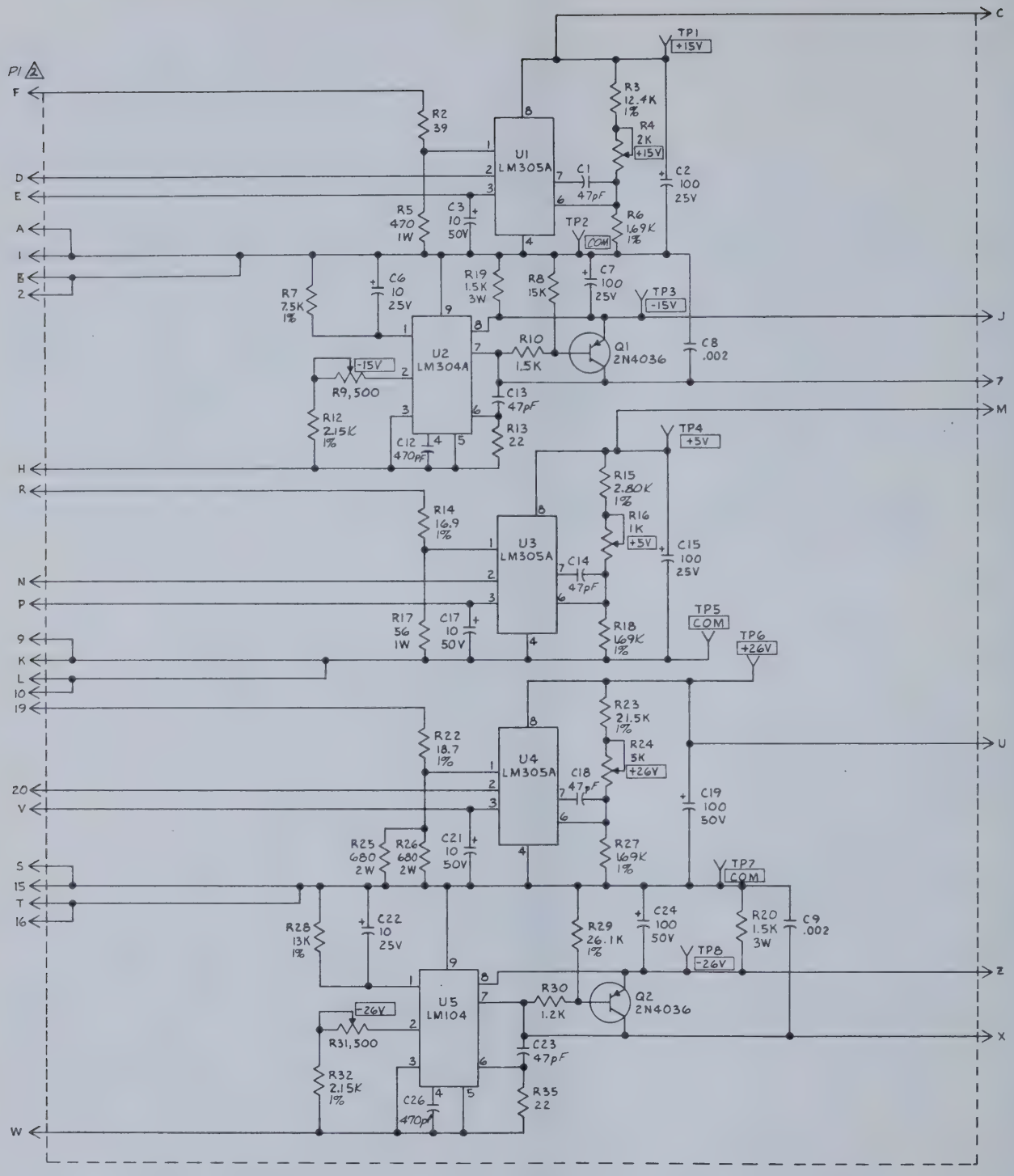
Figure 7-15. Power Supply Assembly (A2), Component Location



NOTE

REFERENCE DESIGNATIONS NOT USED: Q6 & Q7

Figure 7-16. Power Supply Assembly (A2), Schematic



NOTE:

1. REFERENCE SYMBOLS NOT USED C4, C5, C10, C11, C16, C20 & C25. R1, R11, R21, R33 & R34
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-18. Voltage Regulator Printed Circuit Board (A2A1), Schematic

162958B

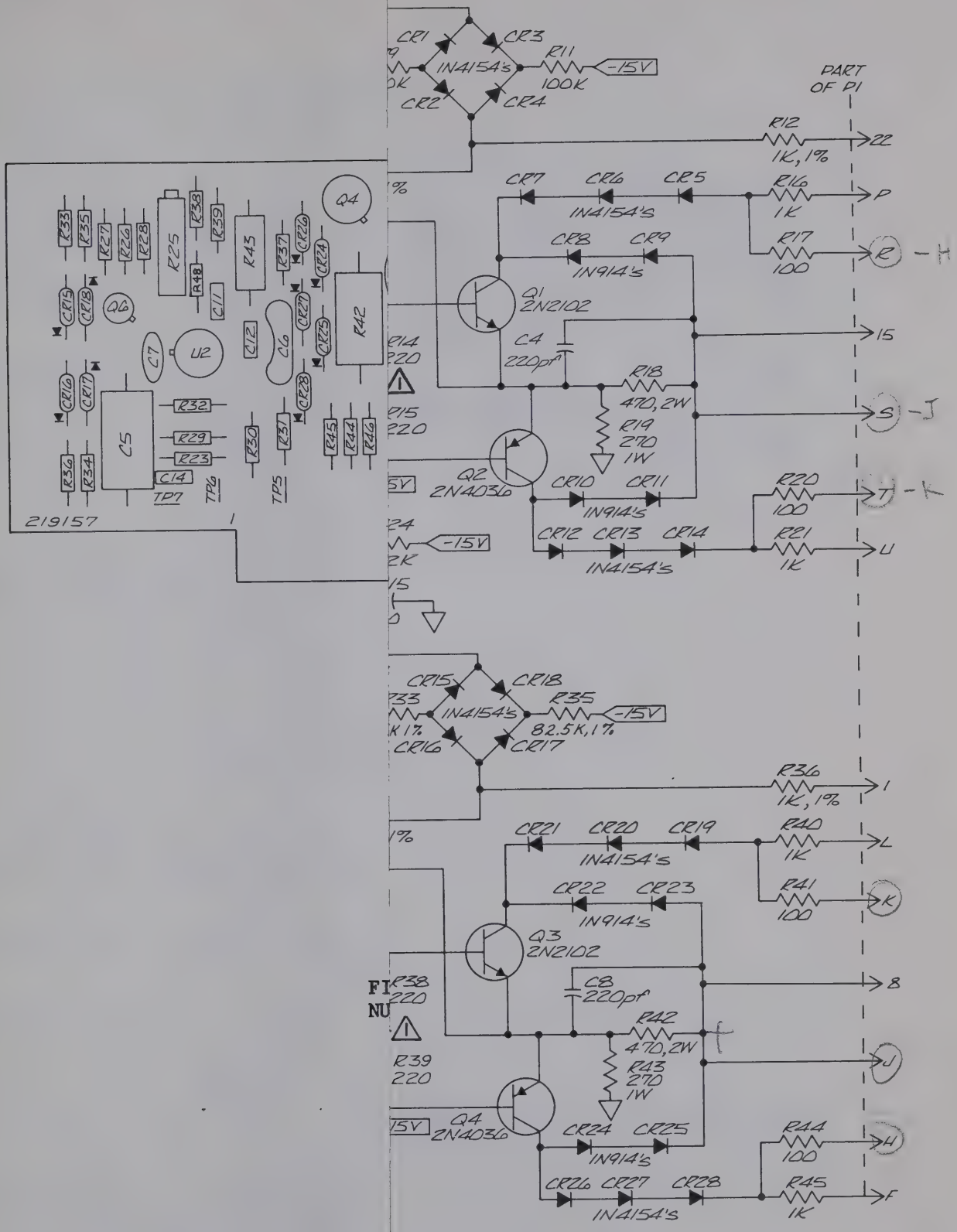
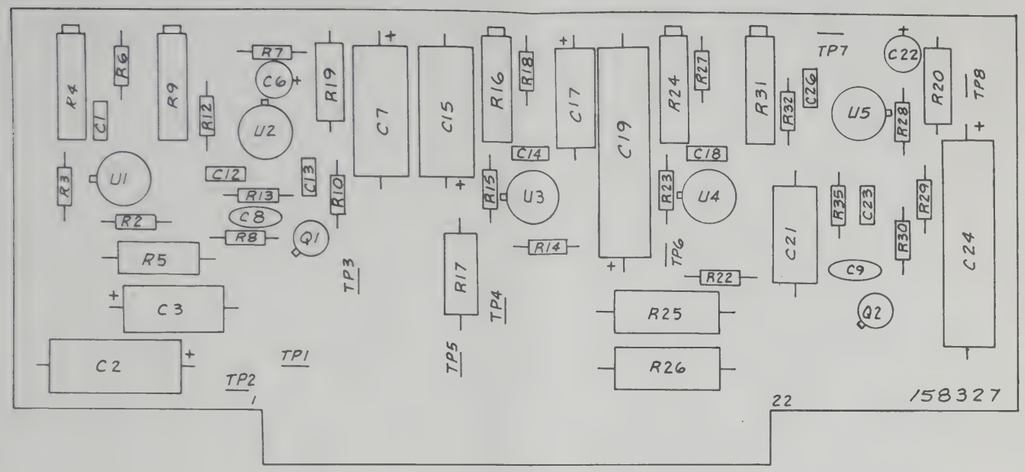


Figure 7-19. System Servo Amplifier Circuit Board (A2A2), Component Location

Figure 7-20. System Servo Amplifier Printed Circuit Board (A2A2), Schematic



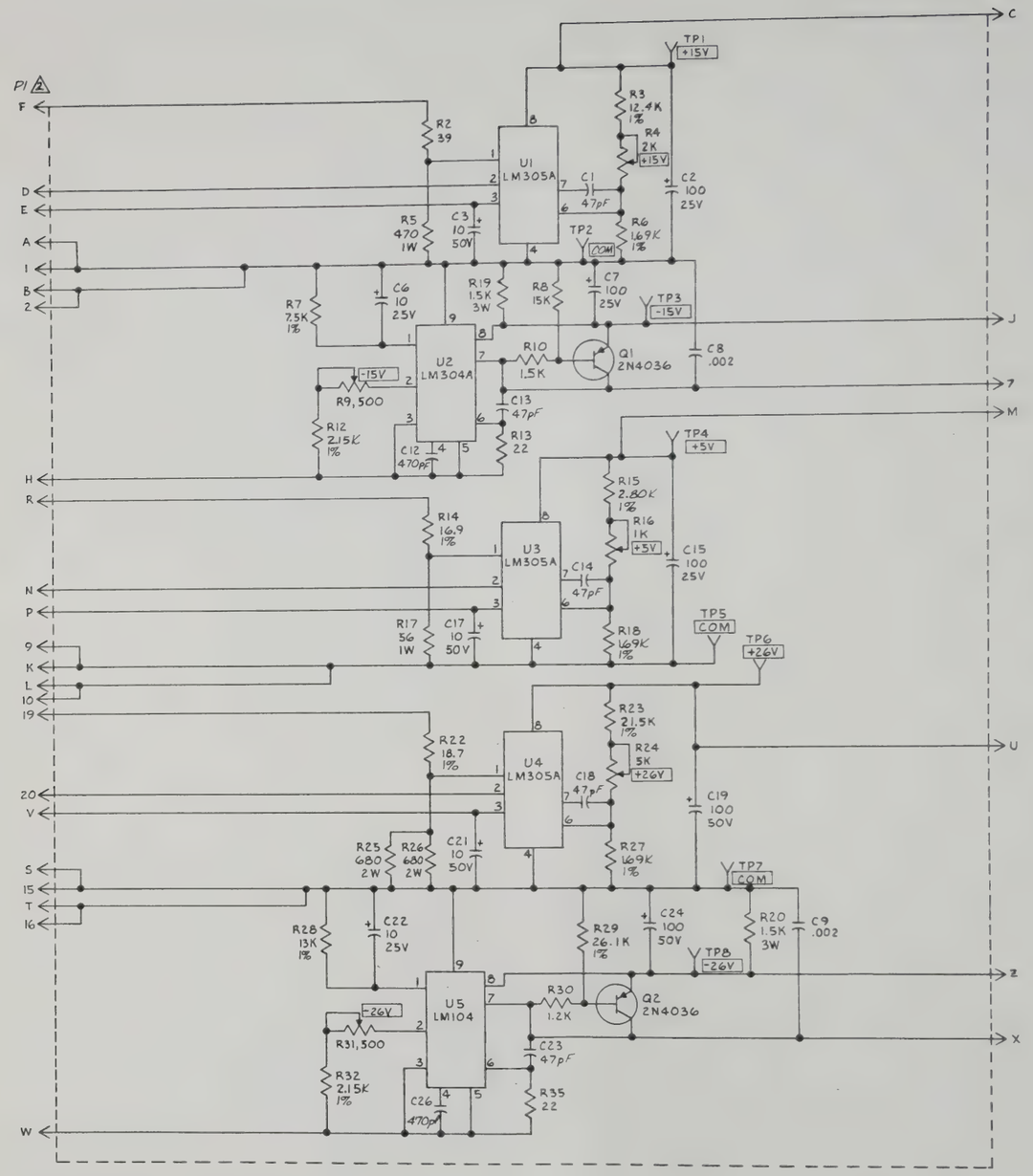
NOTE:

1. REFERENCE DESIGNATIONS NOT USED:
   C4, C5, C10, C11, C16, C20, C25
   R1, R11, R21, R33, R34,

Figure 7-17. Voltage Regulator Printed Circuit Board (A2A1), Component Location

158327B

41R038E

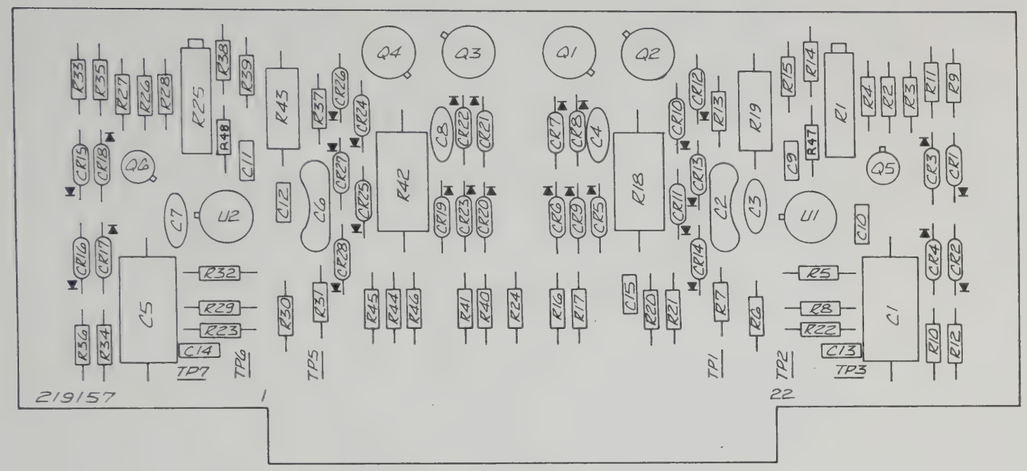


NOTE:

1. REFERENCE SYMBOLS NOT USED C4, C5, C10, C11, C16, C20 & C25. R1, R11, R21, R33 & R34
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

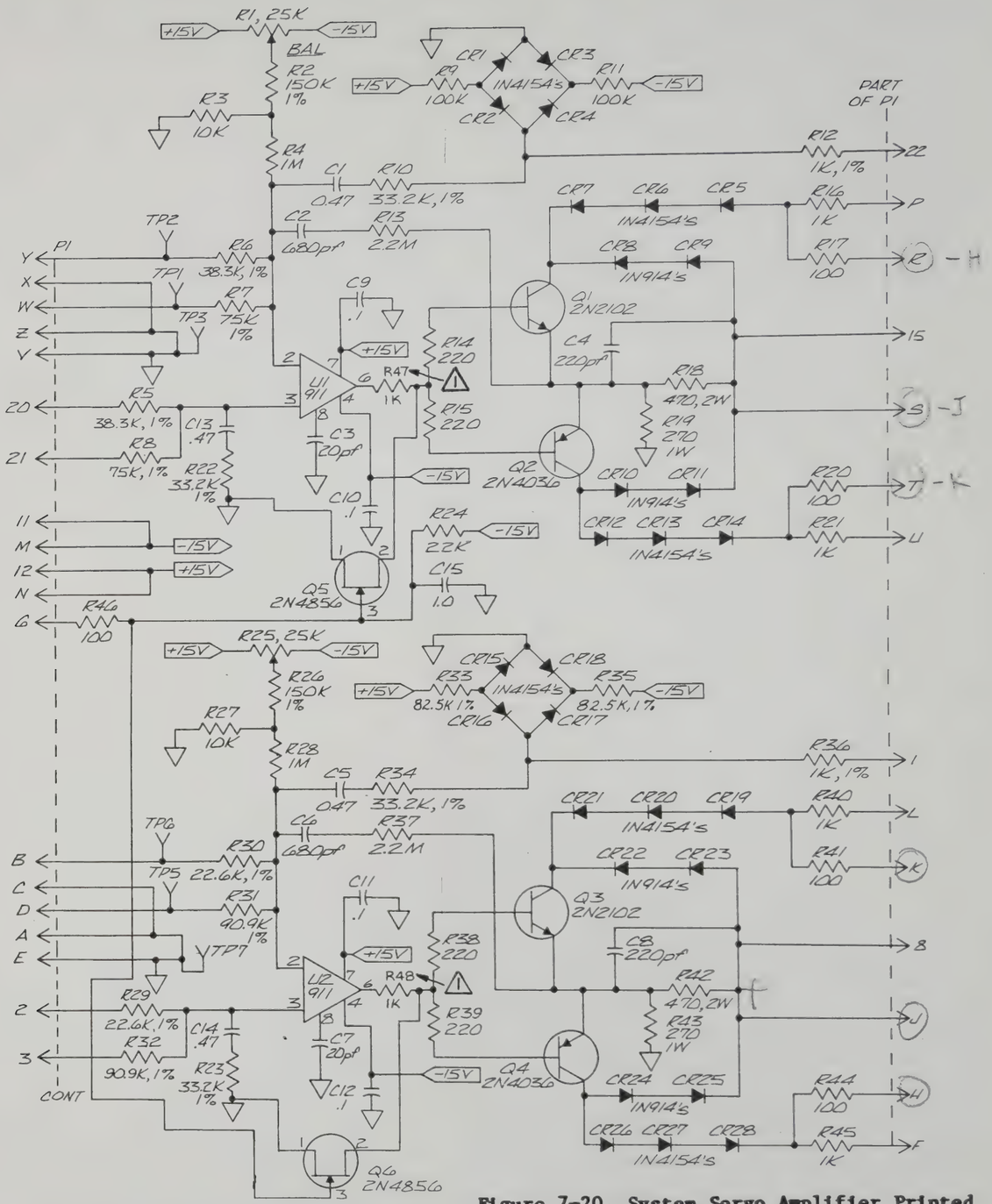
Figure 7-18. Voltage Regulator Printed Circuit Board (A2A1), Schematic

162958B



FIGURES 7-19 AND 7-20 APPLY TO UNITS WITH SERIAL NUMBERS 16 THROUGH 374 (APPROXIMATELY)

Figure 7-19. System Servo Amplifier Printed Circuit Board (A2A2), Component Location



NOTES

1. R47 AND R48 ARE EACH 100Ω IN UNITS WITH SERIAL NUMBERS 325 AND ABOVE.
2. REFERENCE SYMBOLS NOT USED: TP4

Figure 7-20. System Servo Amplifier Printed Circuit Board (A2A2), Schematic

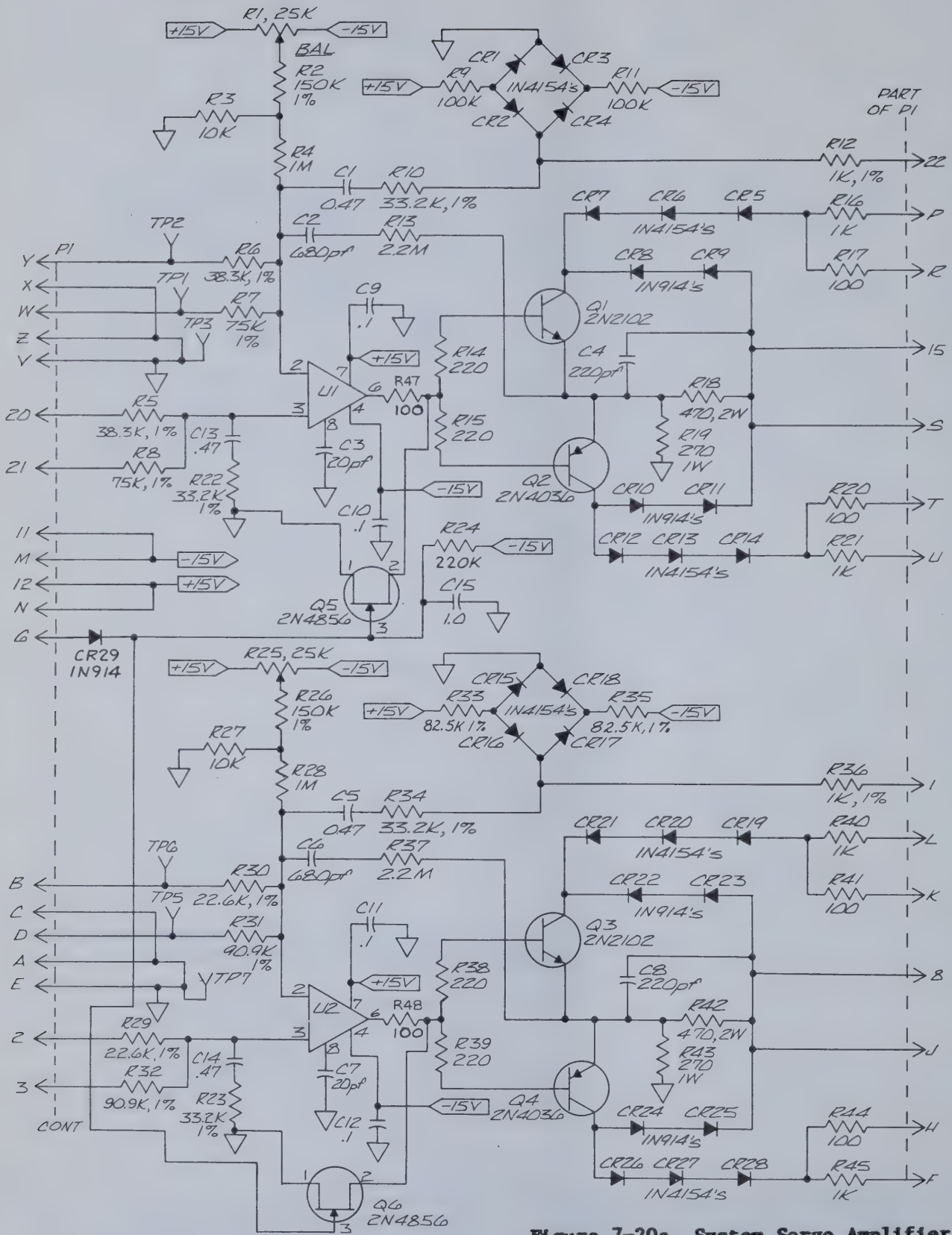
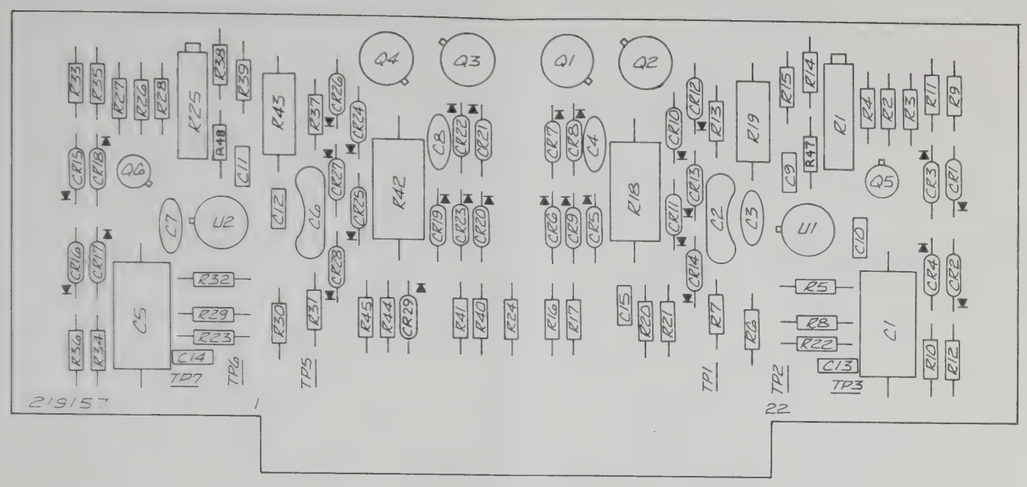


Figure 7-20a. System Servo Amplifier Printed Circuit Board (A2A2), Schematic

219155D

SERIES 1580 PATTERN RECORDER,
DATA PROCESSOR ASSEMBLY (A3)



FIGURES 7-19A AND 7-20A APPLY TO UNITS WITH SERIAL NUMBERS 375 AND ABOVE (APPROXIMATELY)

Figure 7-19a. System Servo Amplifier Printed Circuit Board (A2A2), Component Location

219157E

41R038F

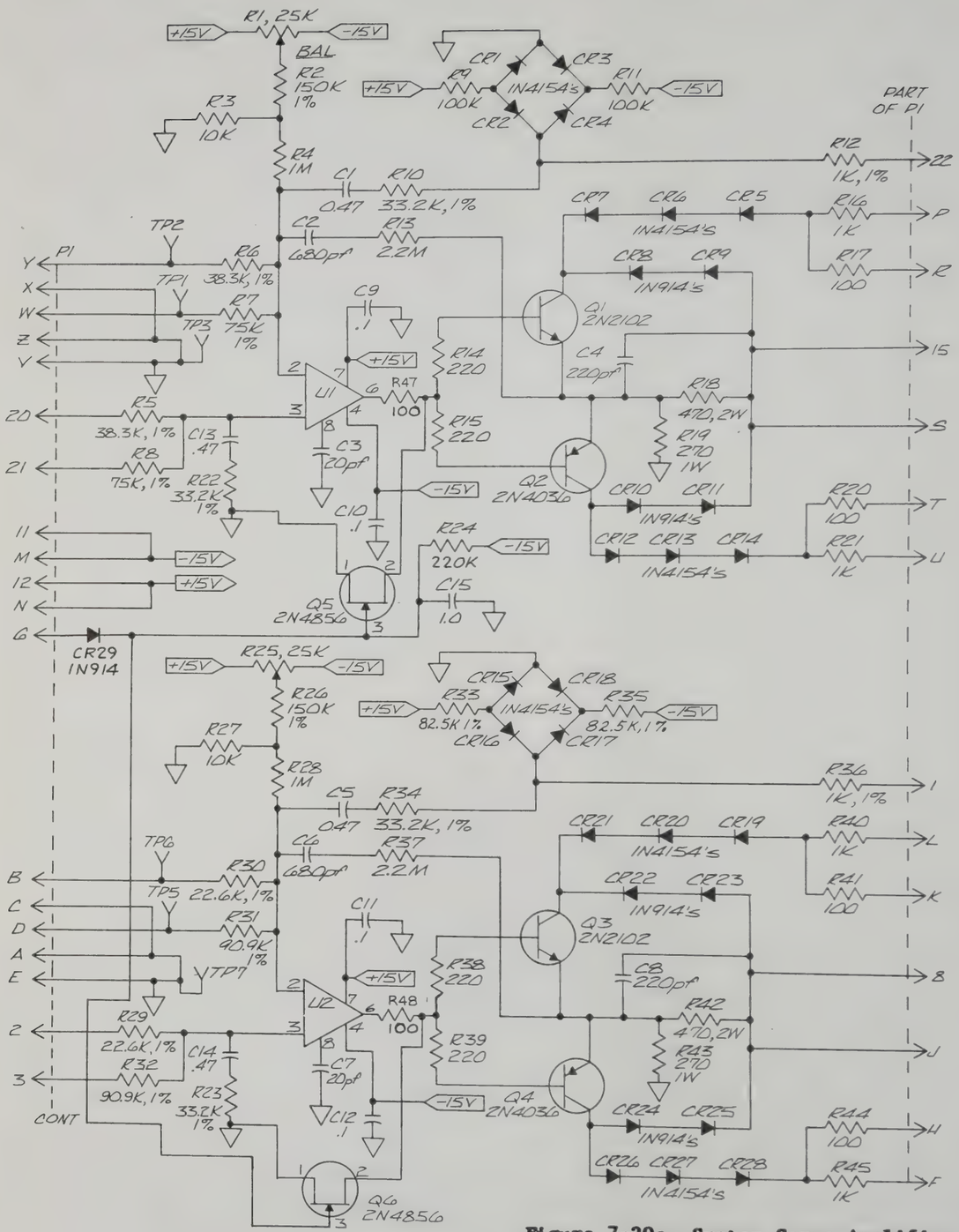
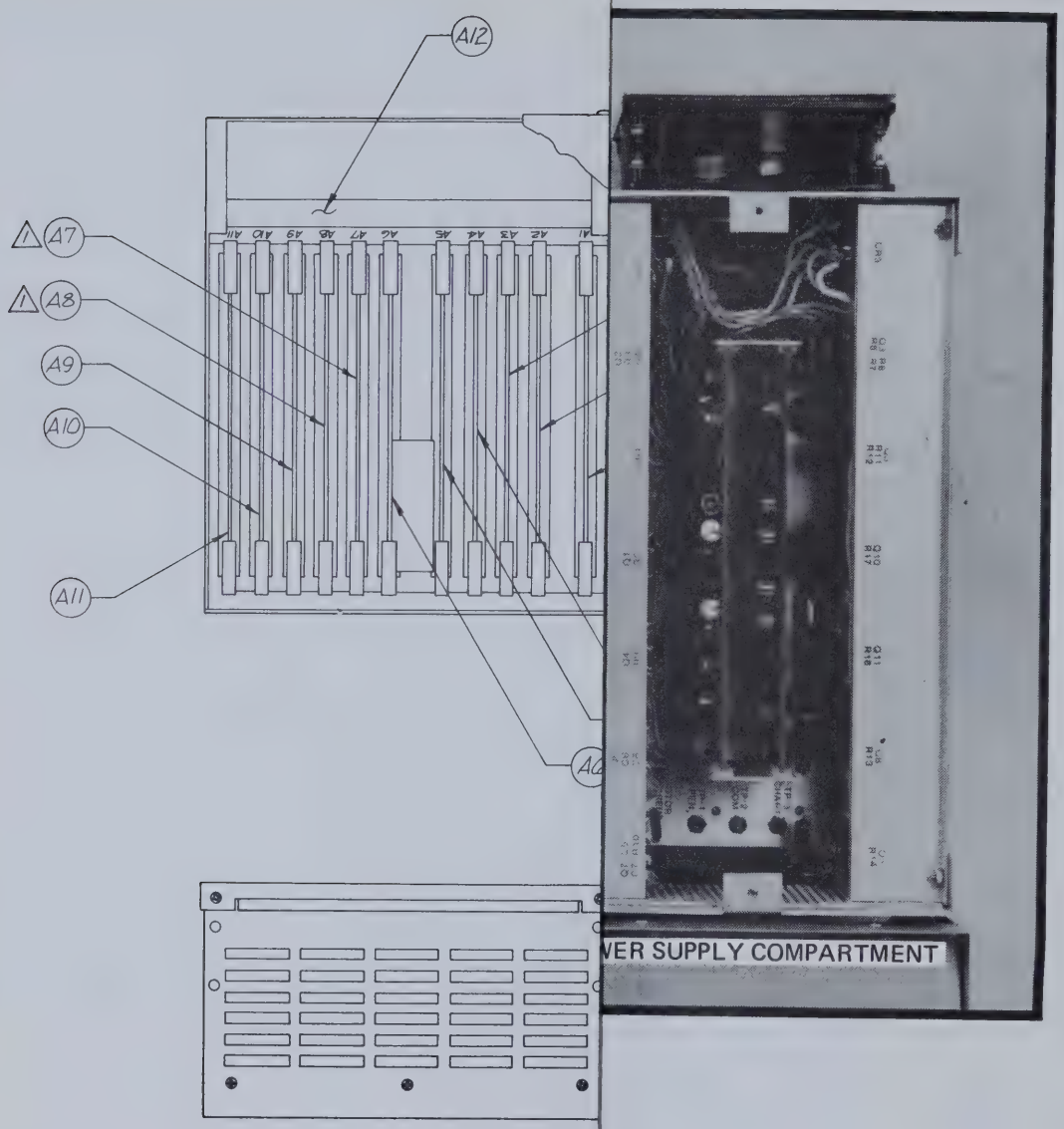


Figure 7-20a. System Servo Amplifier Printed Circuit Board (A2A2), Schematic

219155D

SERIES 1580 PATTERN RECORDER,
DATA PROCESSOR ASSEMBLY (A3)



NOTES:

1. A4, A7, & A8 ARE OPTIONS.
2. A5 AND A6 SELECTED BY CUSTO

Figure 7-21. Data Processor Assembly (A3) Component Location

re 7-22. Power Supply Assembly (A2) and Data Processor Assembly (A3) Components With Safety Covers Removed

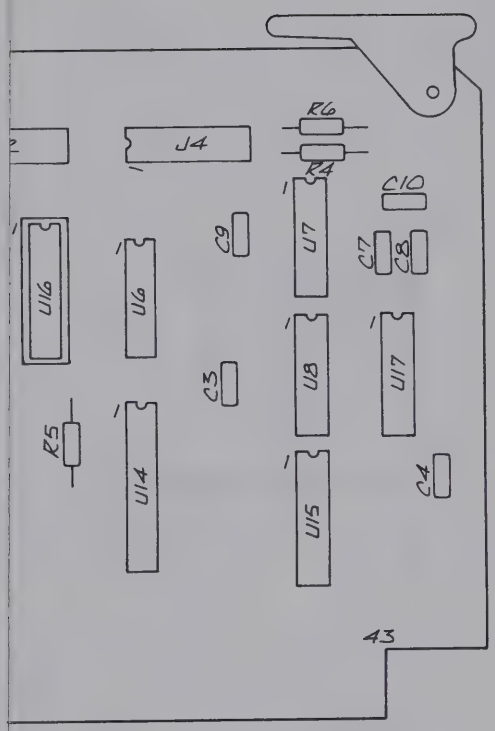
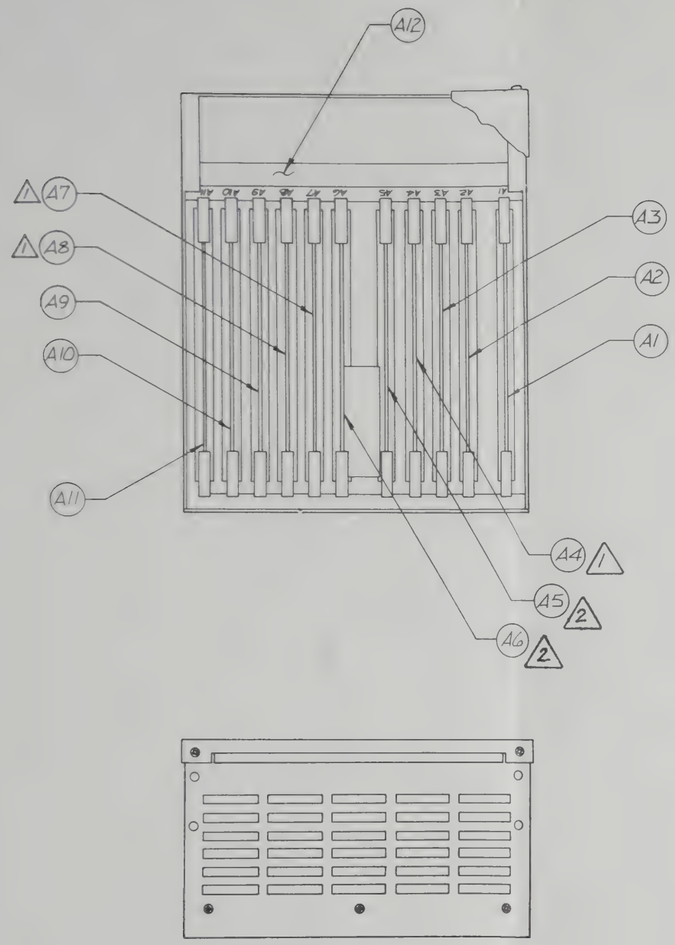


Figure 7-23. Control Panel Interface Printed Circuit Board (A3A1), Component Location



NOTES:

1. A4, A7, & A8 ARE OPTIONS.
2. A5 AND A6 SELECTED BY CUSTOMER.

Figure 7-21. Data Processor Assembly (A3), Component Location

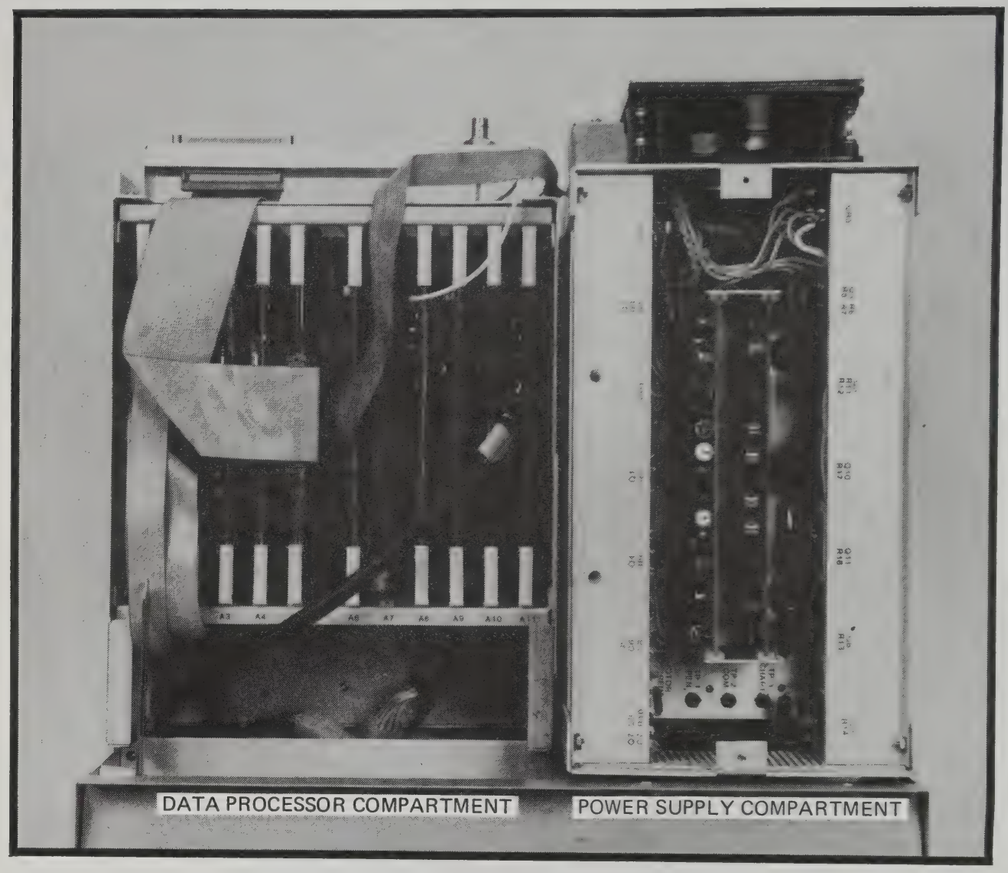


Figure 7-22. Power Supply Assembly (A2) and Data Processor Assembly (A3) Components With Safety Covers Removed

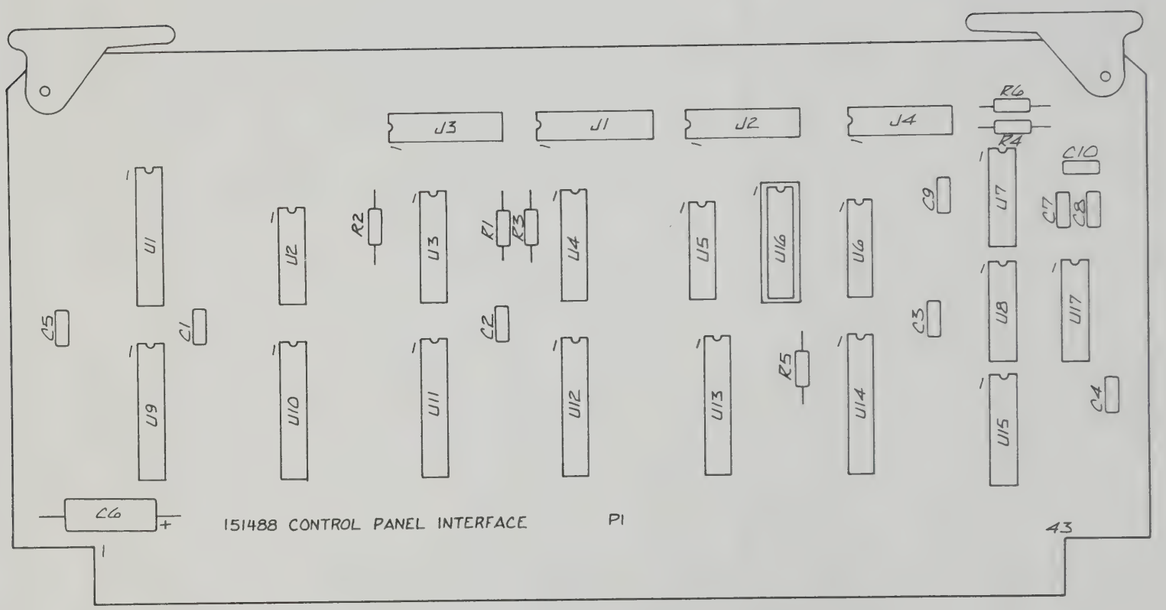


Figure 7-23. Control Panel Interface Printed Circuit Board (A3A1), Component Location

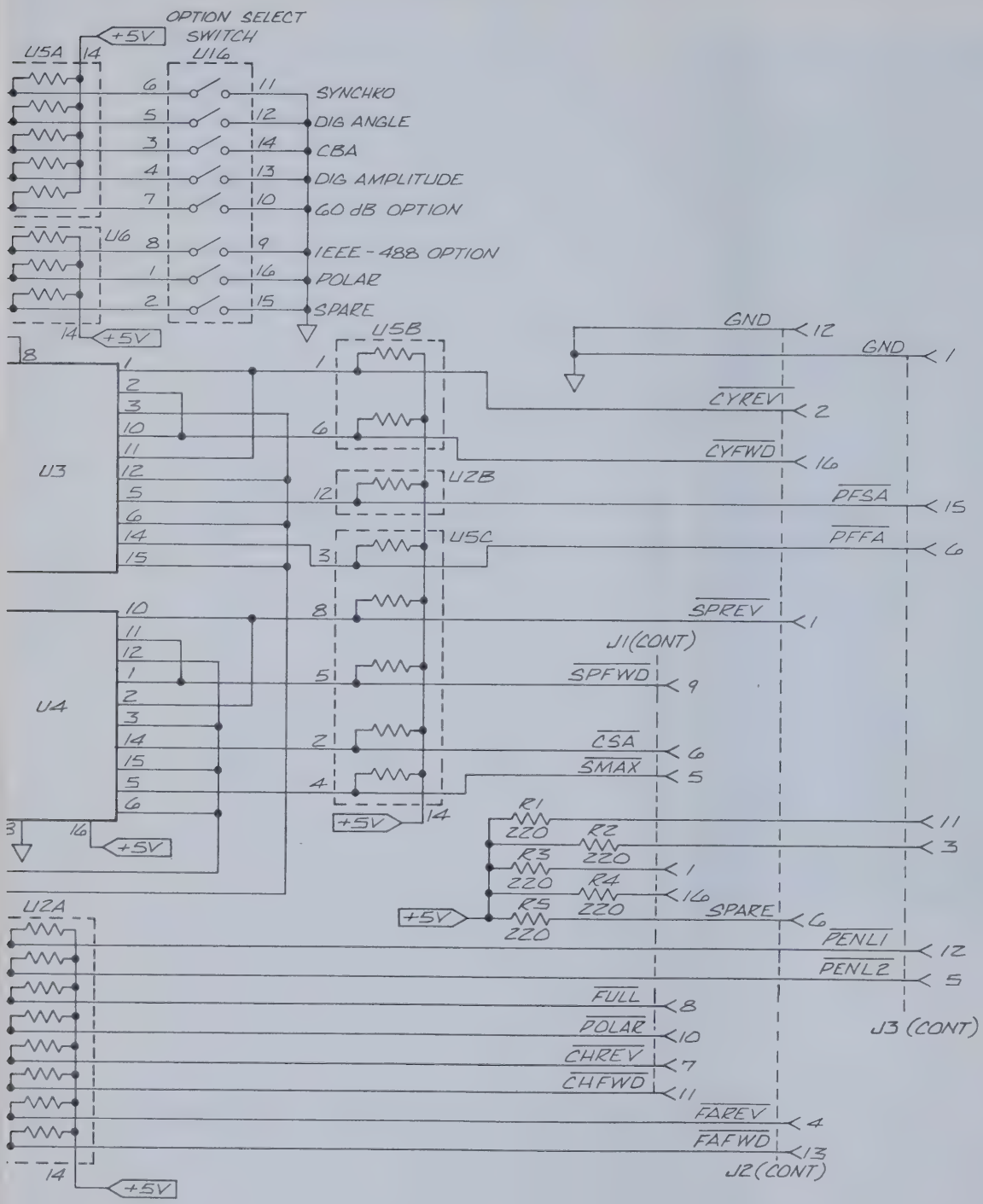
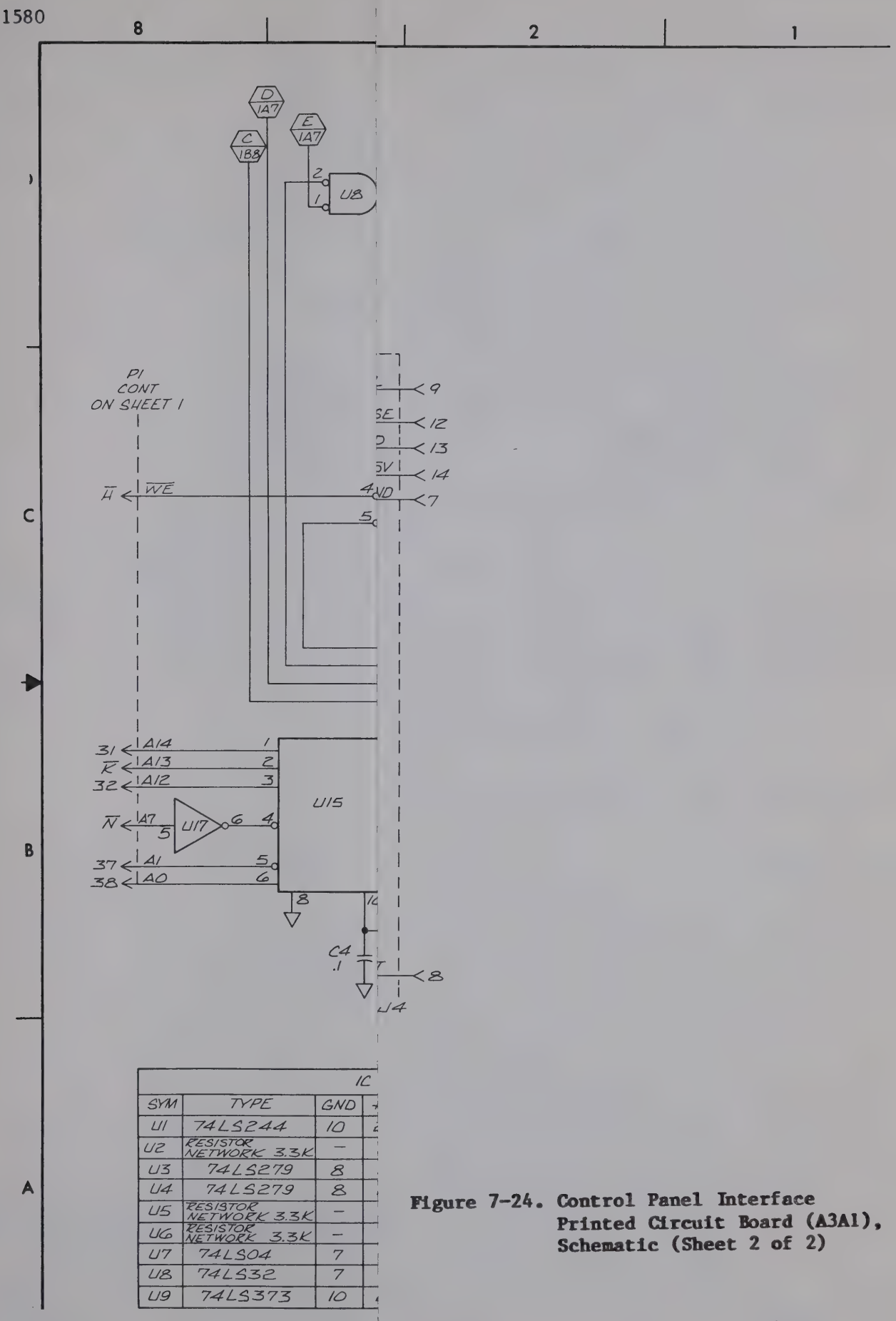
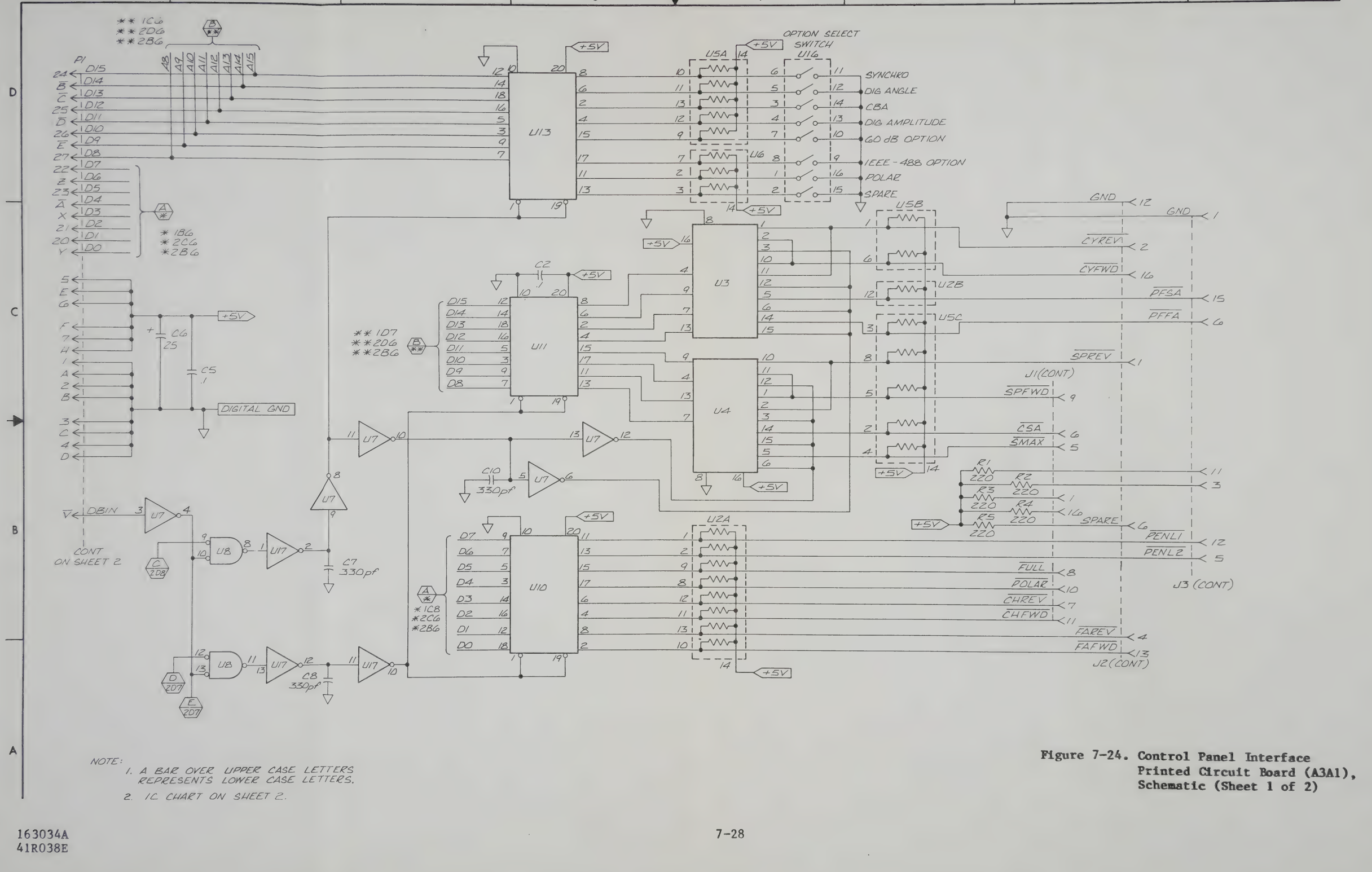


Figure 7-24. Control Panel Interface Printed Circuit Board (A3A1), Schematic (Sheet 1 of 2)



IC			
SYM	TYPE	GND	
U1	74LS244	10	
U2	RESISTOR NETWORK 3.3K	—	
U3	74LS279	8	
U4	74LS279	8	
U5	RESISTOR NETWORK 3.3K	—	
U6	RESISTOR NETWORK 3.3K	—	
U7	74LS04	7	
U8	74LS32	7	
U9	74LS373	10	

Figure 7-24. Control Panel Interface Printed Circuit Board (A3A1), Schematic (Sheet 2 of 2)



NOTE:
1. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
2. IC CHART ON SHEET 2.

Figure 7-24. Control Panel Interface Printed Circuit Board (A3A1), Schematic (Sheet 1 of 2)

IC CHART							
SYM	TYPE	GND	+5V	SYM	TYPE	GND	+5V
U1	74LS244	10	20	U10	74LS244	10	20
U2	RESISTOR NETWORK 3.3K	–	14	U11	74LS244	10	20
U3	74LS279	8	16	U12	74LS373	10	20
U4	74LS279	8	16	U13	74LS244	10	20
U5	RESISTOR NETWORK 3.3K	–	14	U14	74LS244	10	20
U6	RESISTOR NETWORK 3.3K	–	14	U15	74LS138	8	16
U7	74LS04	7	14	U16	SWITCH NETWORK	–	–
U8	74LS32	7	14	U17	74LS04	7	14
U9	74LS373	10	20				

Figure 7-24. Control Panel Interface Printed Circuit Board (A3A1), Schematic (Sheet 2 of 2)

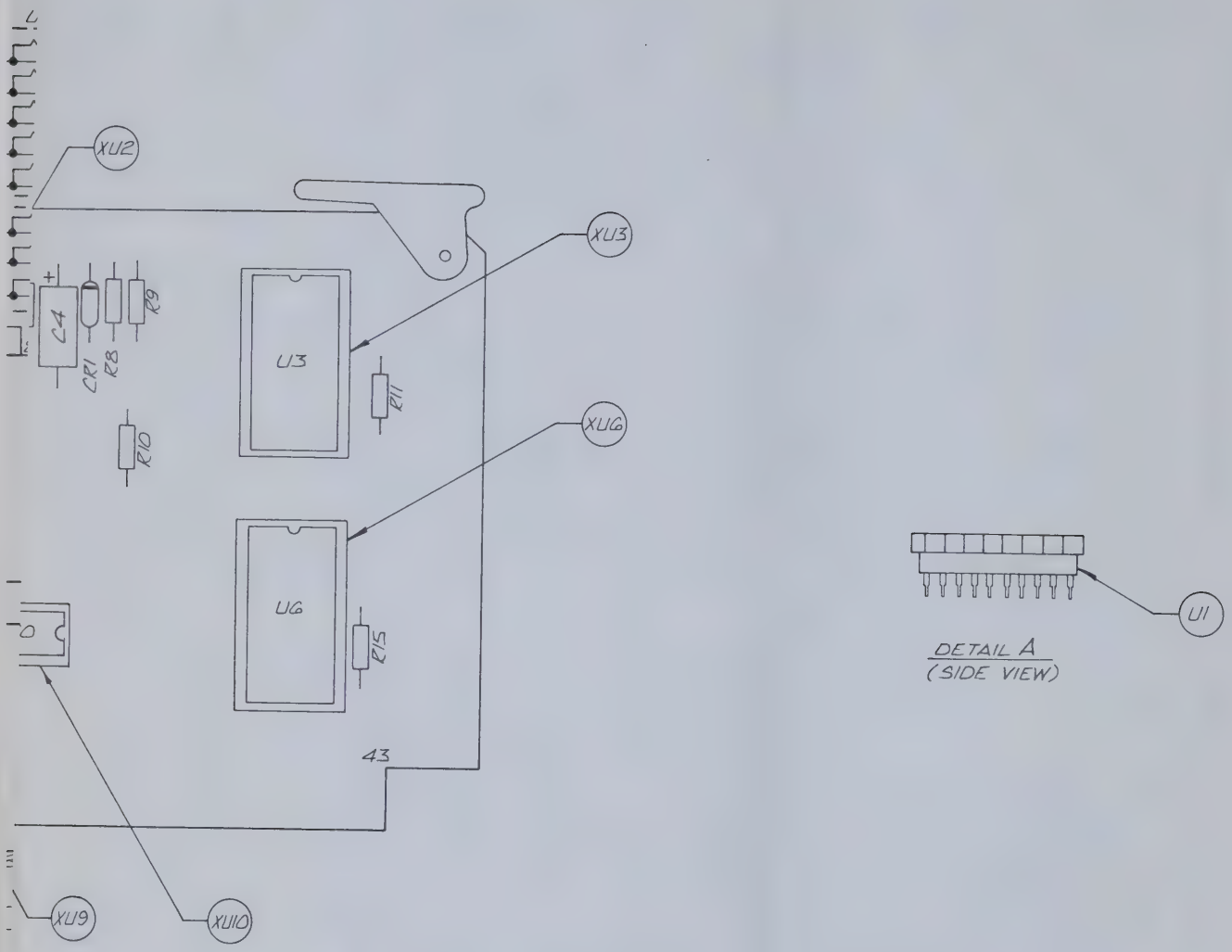


Figure 7-25. Central Processor Unit (CPU) Printed Circuit Board (A3A2), Component Location

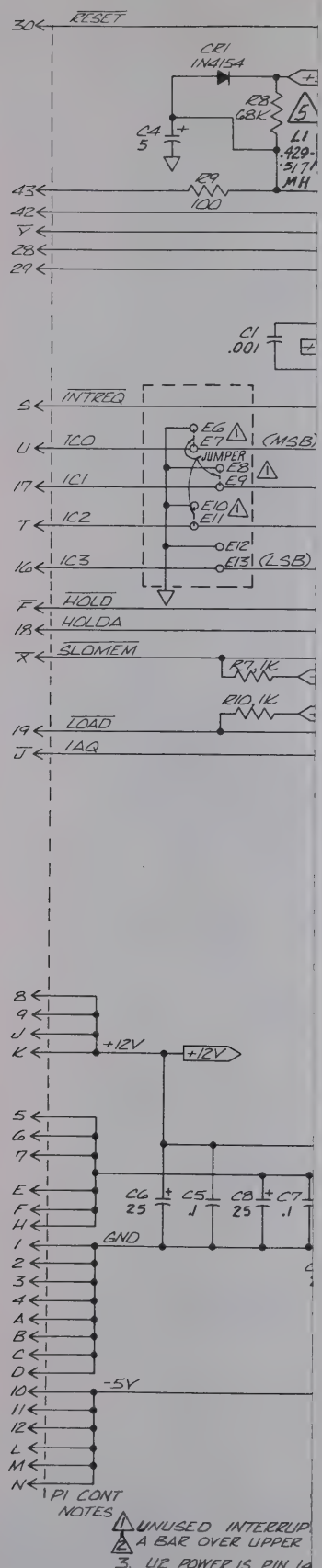
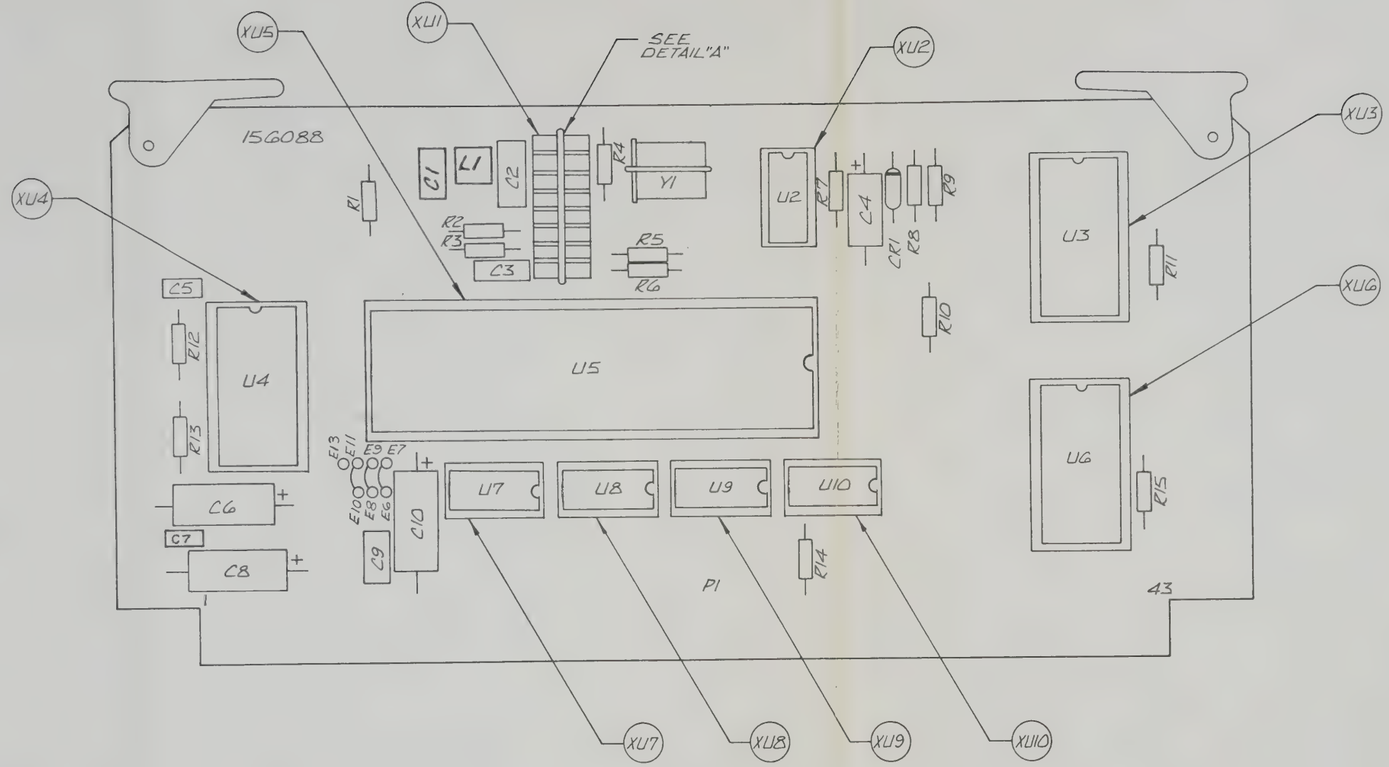


Figure 7-26. Central Processor Unit (CPU) Printed Circuit Board (A3A2), Schematic



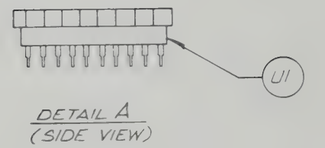
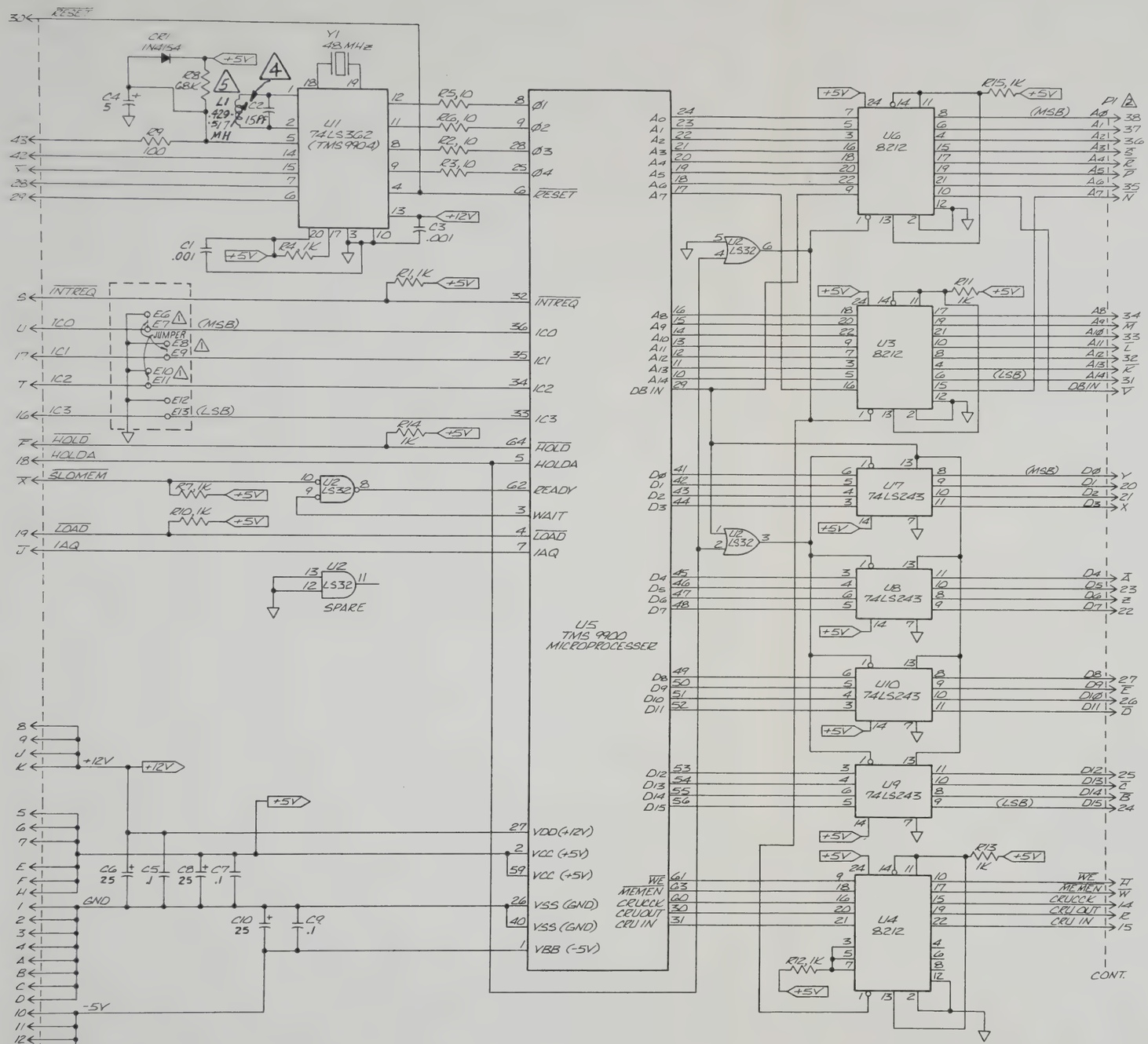


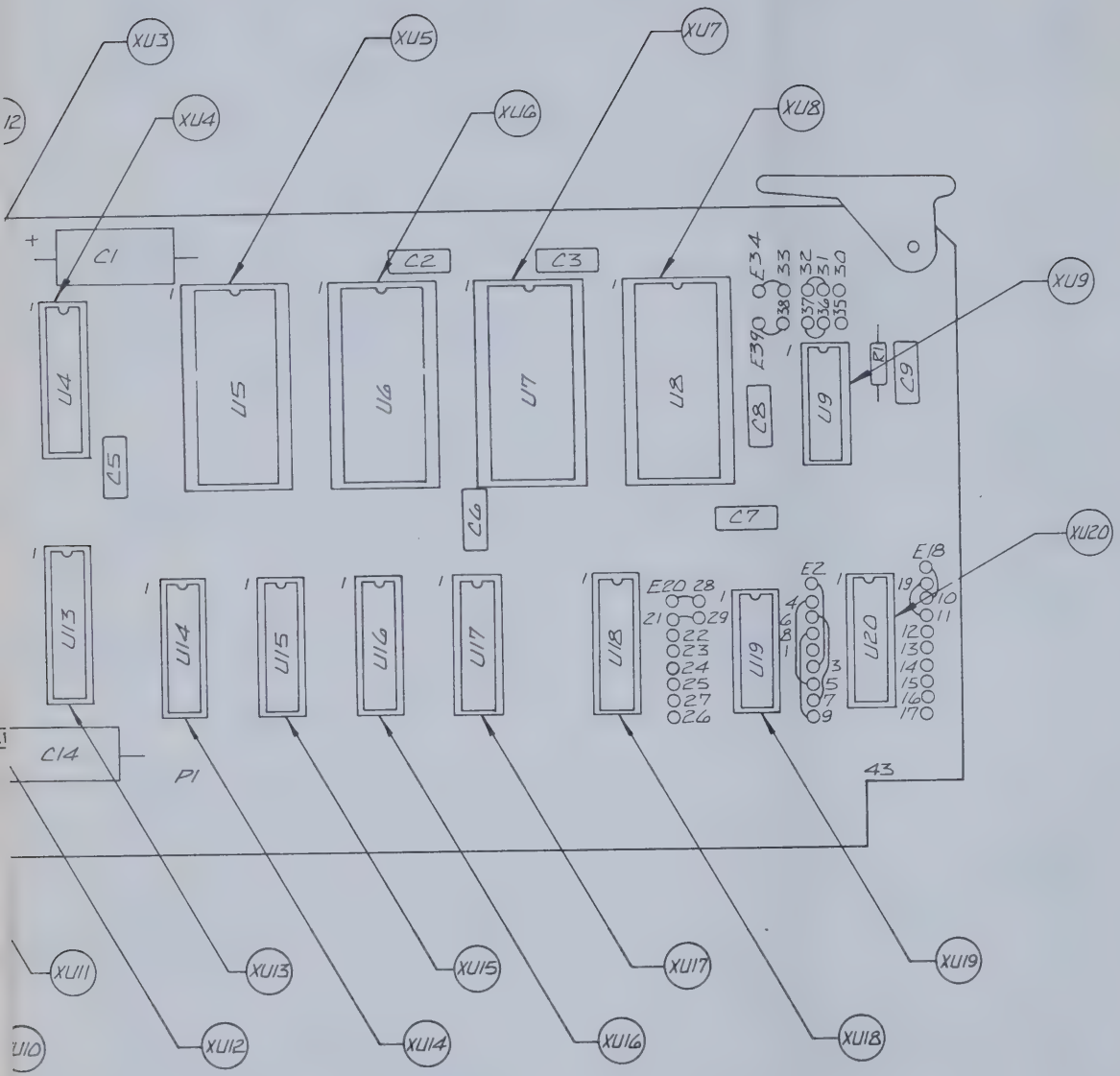
Figure 7-25. Central Processor Unit (CPU) Printed Circuit Board (A3A2), Component Location



NOTES

1. UNUSED INTERRUPTS MUST BE TIED TO GROUND.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
3. U2 POWER IS PIN 14 & GROUND IS PIN 7.
4. C2 IS 18PF IN SERIAL NO. 324 AND BELOW (SERIAL NO. APPROXIMATE)
5. L1 VALUE IS FIXED AT .47µH ON SERIAL NUMBER 551 AND BELOW (APPROXIMATELY).

Figure 7-26. Central Processor Unit (CPU) Printed Circuit Board (A3A2), Schematic



APPLIES TO UNITS WITH SERIAL NUMBERS 401 AND BELOW (APPROXIMATELY)

Figure 7-27. Main Memory (1) Printed Circuit Board (A3A3), Component Location

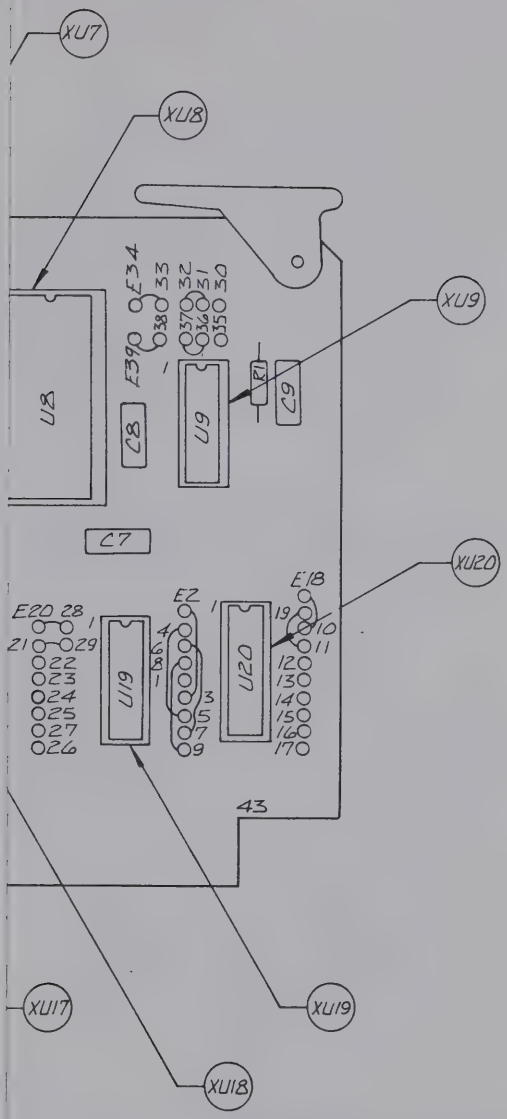
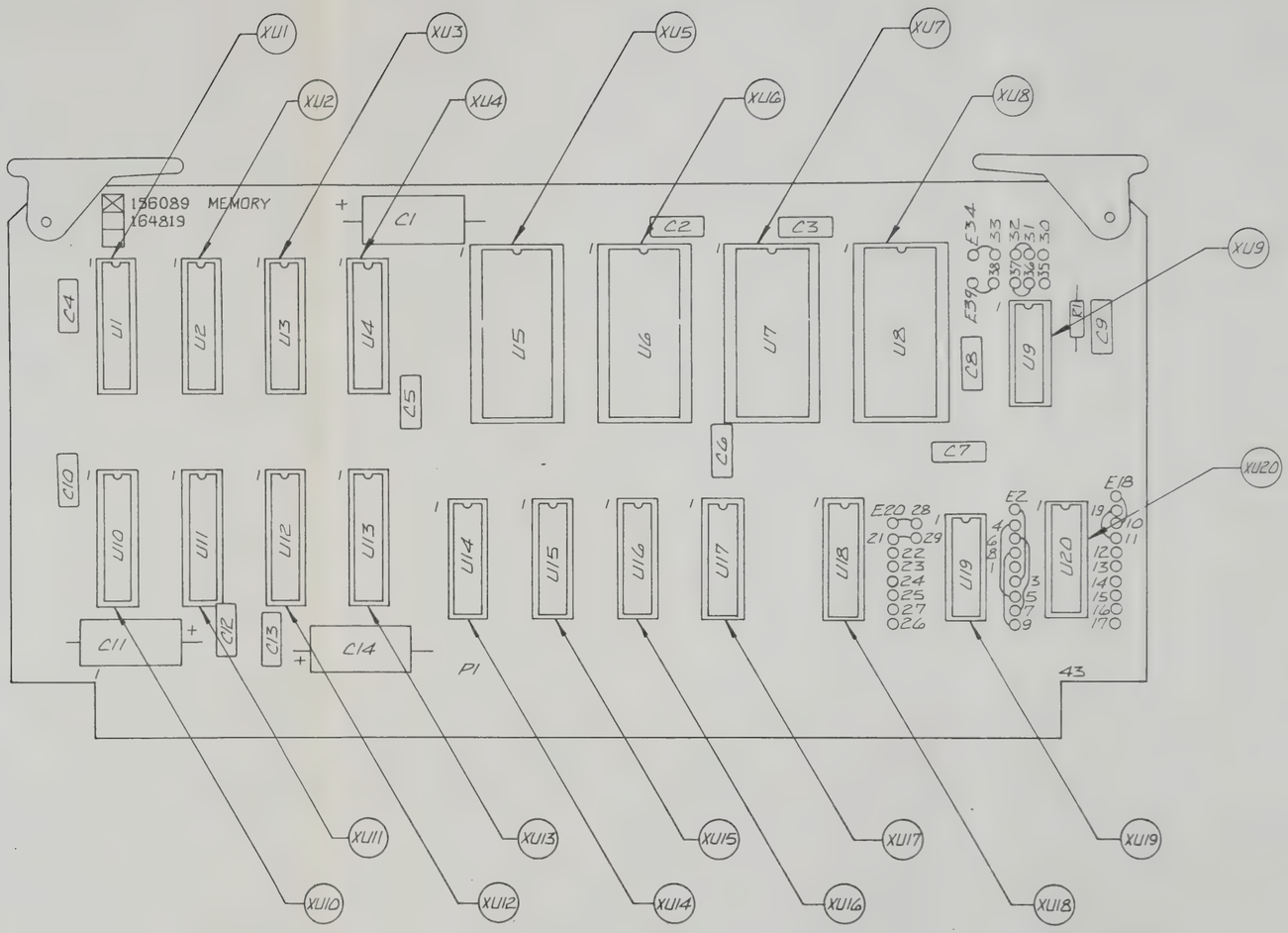
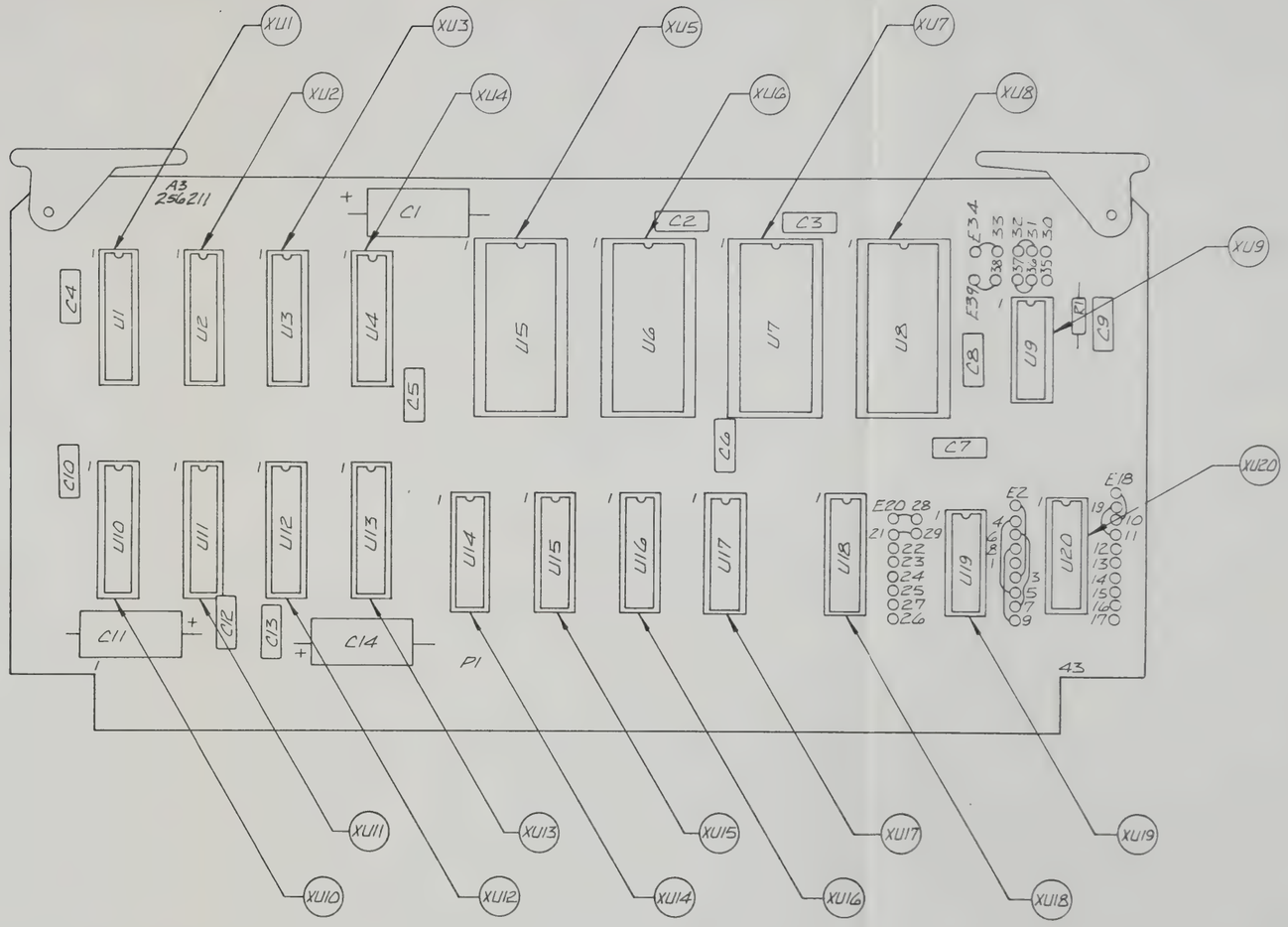


Figure 7-27a. Main Memory (1) Printed Circuit Baord (A3A3), Component Location



APPLIES TO UNITS WITH SERIAL NUMBERS 401 AND BELOW (APPROXIMATELY)

Figure 7-27. Main Memory (1) Printed Circuit Board (A3A3), Component Location



APPLIES TO UNITS WITH SERIAL NUMBERS 402 AND ABOVE (APPROXIMATELY)

Figure 7-27a. Main Memory (1) Printed Circuit Baord (A3A3), Component Location

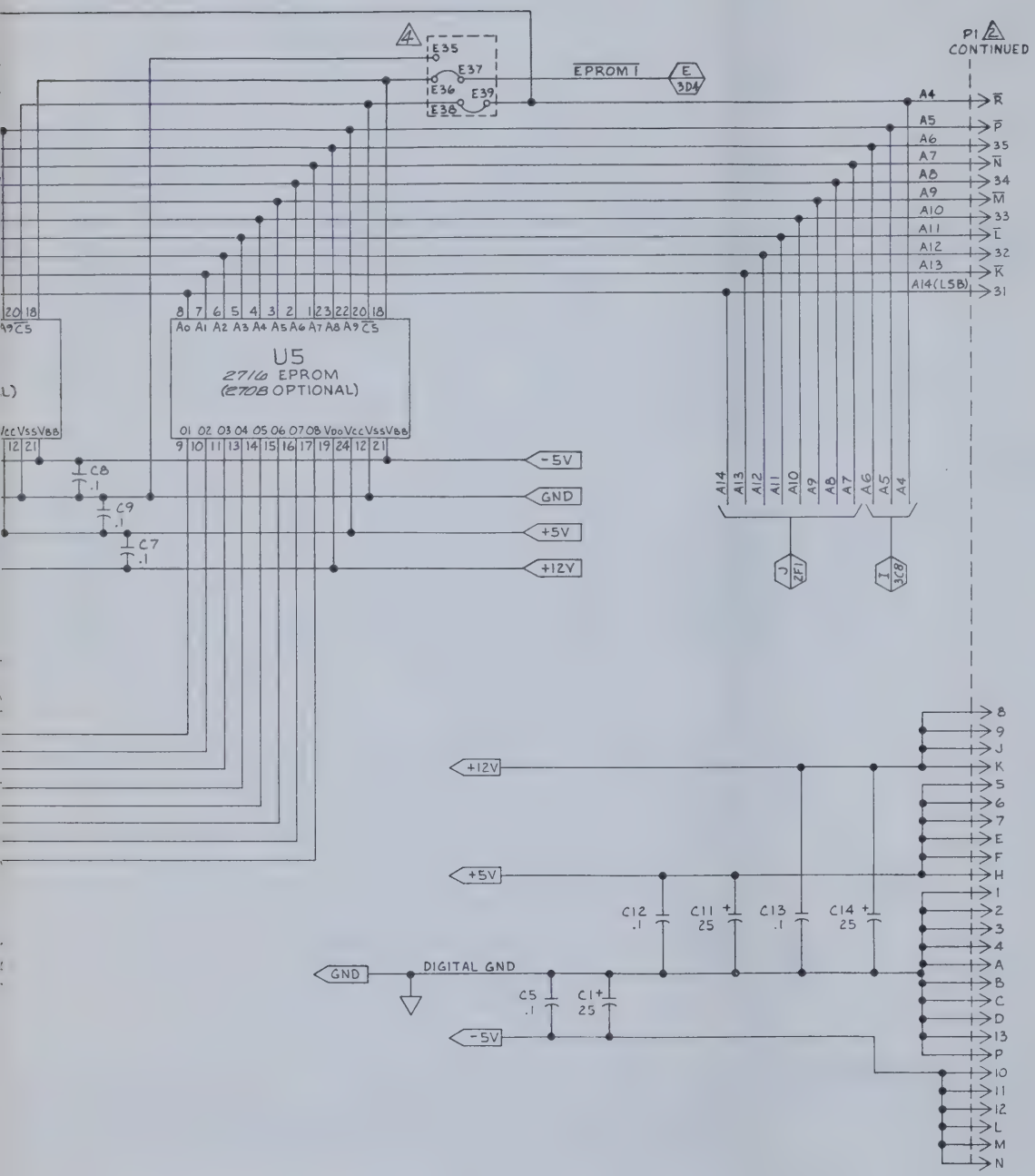


Figure 7-28. Main Memory (1) Printed Circuit Baord (A3A3), Schematic (Sheet 1 of 3)

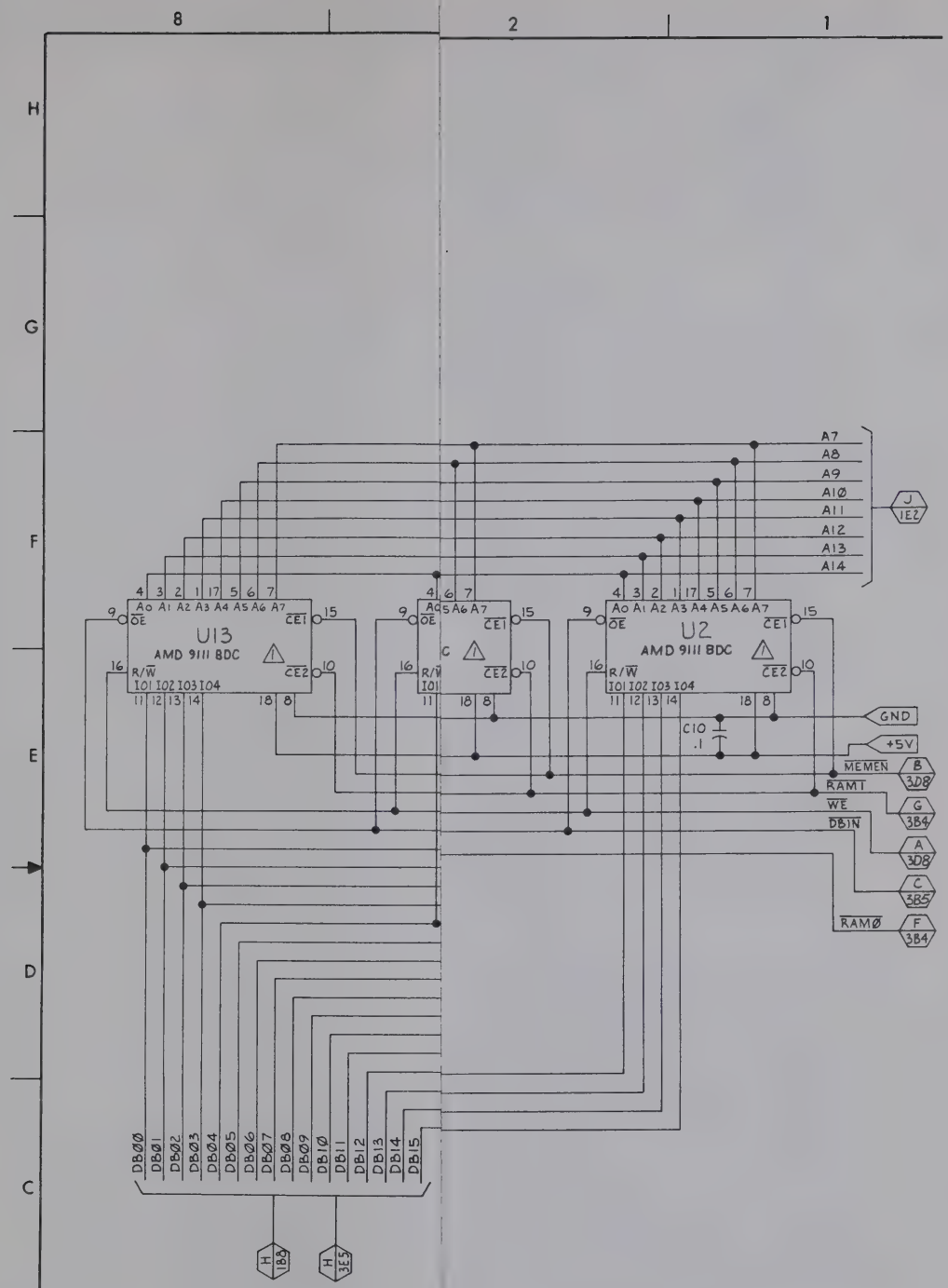


Figure 7-28. Main Memory (1) Printed Circuit Baord (A3A3), Schematic (Sheet 2 of 3)

U7 2716 EPROM (2708 OPTIONAL)

U6 2716 EPROM (2708 OPTIONAL)

U8 2716 EPROM (2708 OPTIONAL)

U5 2716 EPROM (2708 OPTIONAL)

EPROM 0

EPROM 1

P1 CONTINUED

-5V

GND

+5V

+12V

DIGITAL GND

NOTES:

1. SEE NOTE 1 ON SHEET 2.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS
3. SEE EXAMPLE FOR EXPLANATION OF CIRCUIT CONTINUATION FLAGS.
4. JUMPER ARRANGEMENT IS SHOWN FOR 2716 TYPE EPROM. FOR OPTIONAL EPROM 2708, ARRANGE JUMPERS: E1 TO E2, E3 TO E4, E5 TO E6, E7 TO E8, E30 TO E31, E32 TO E33, E35 TO E36, & E37 TO E38.

EXAMPLE: MATCH LETTER, ZONE, SHEET NO.

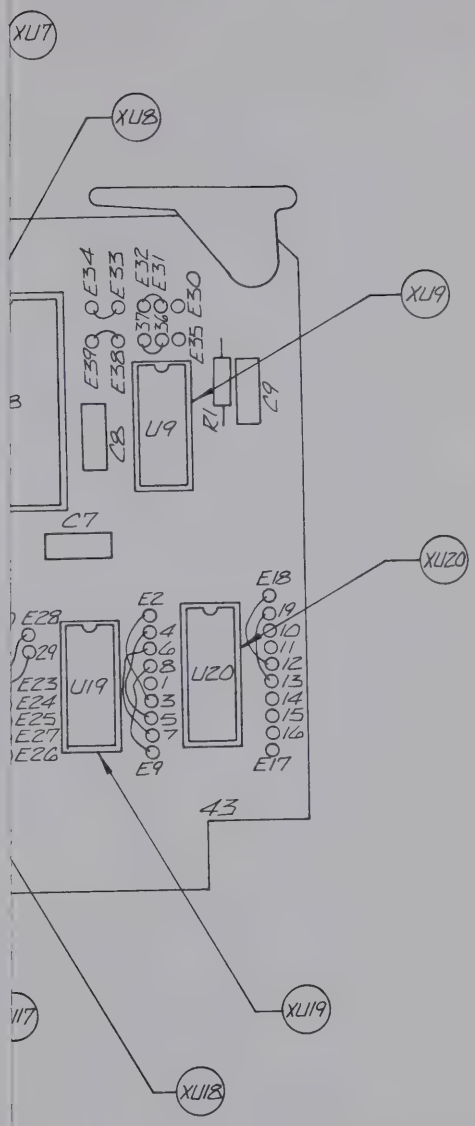
Figure 7-28. Main Memory (1) Printed Circuit Baord (A3A3), Schematic (Sheet 1 of 3)

NOTES:

1. SIGNETICS P/N 2111-I MAY BE USED

Figure 7-28. Main Memory (1) Printed Circuit Baord (A3A3), Schematic (Sheet 2 of 3)

Figure 7-28. Main Memory (1) Printed Circuit Baord (A3A3), Schematic (Sheet 3 of 3)



BELOW (APPROXIMATELY)

Figure 7-29. Optional Memory (2) Printed Circuit Board (A3A4), Component Location

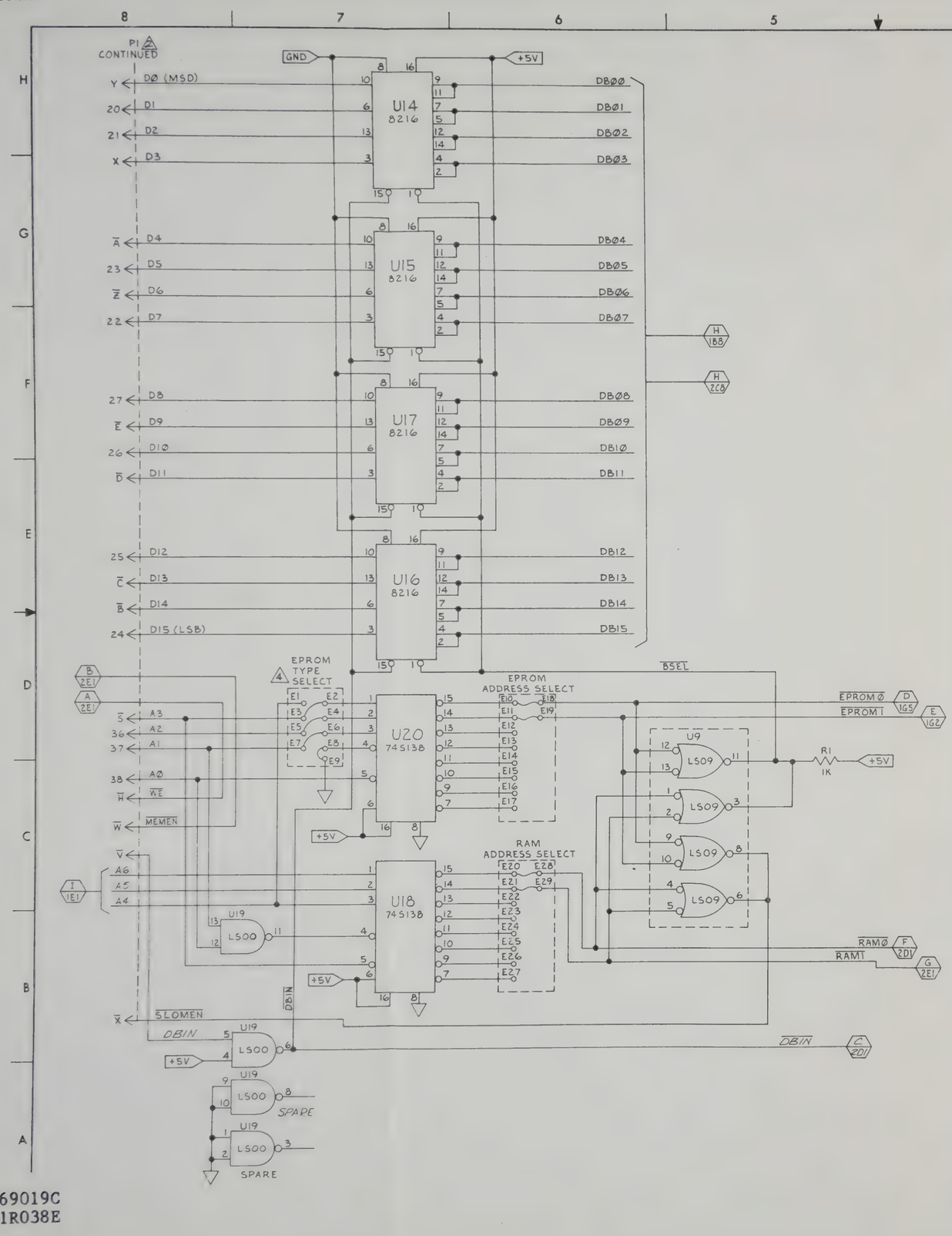
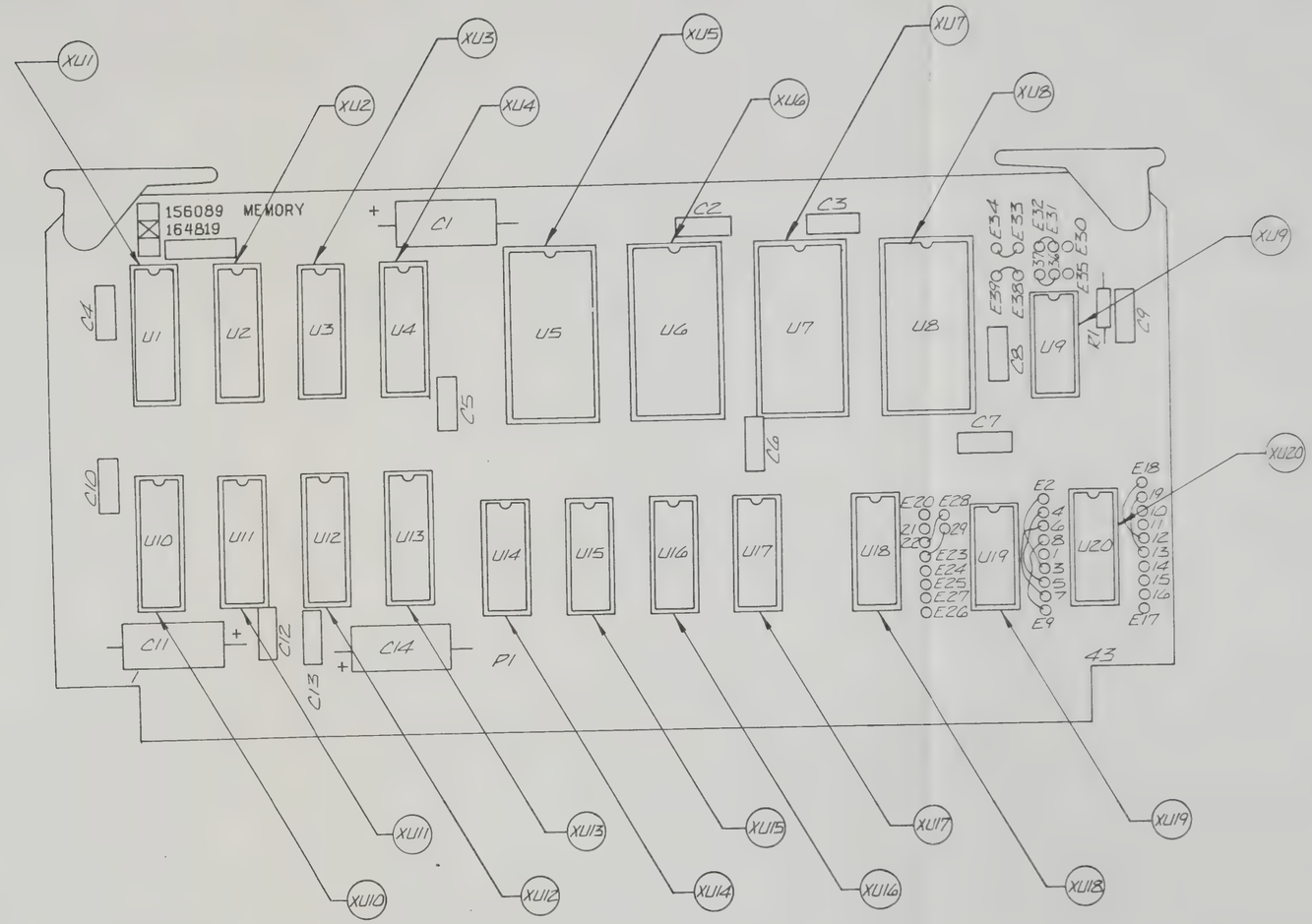
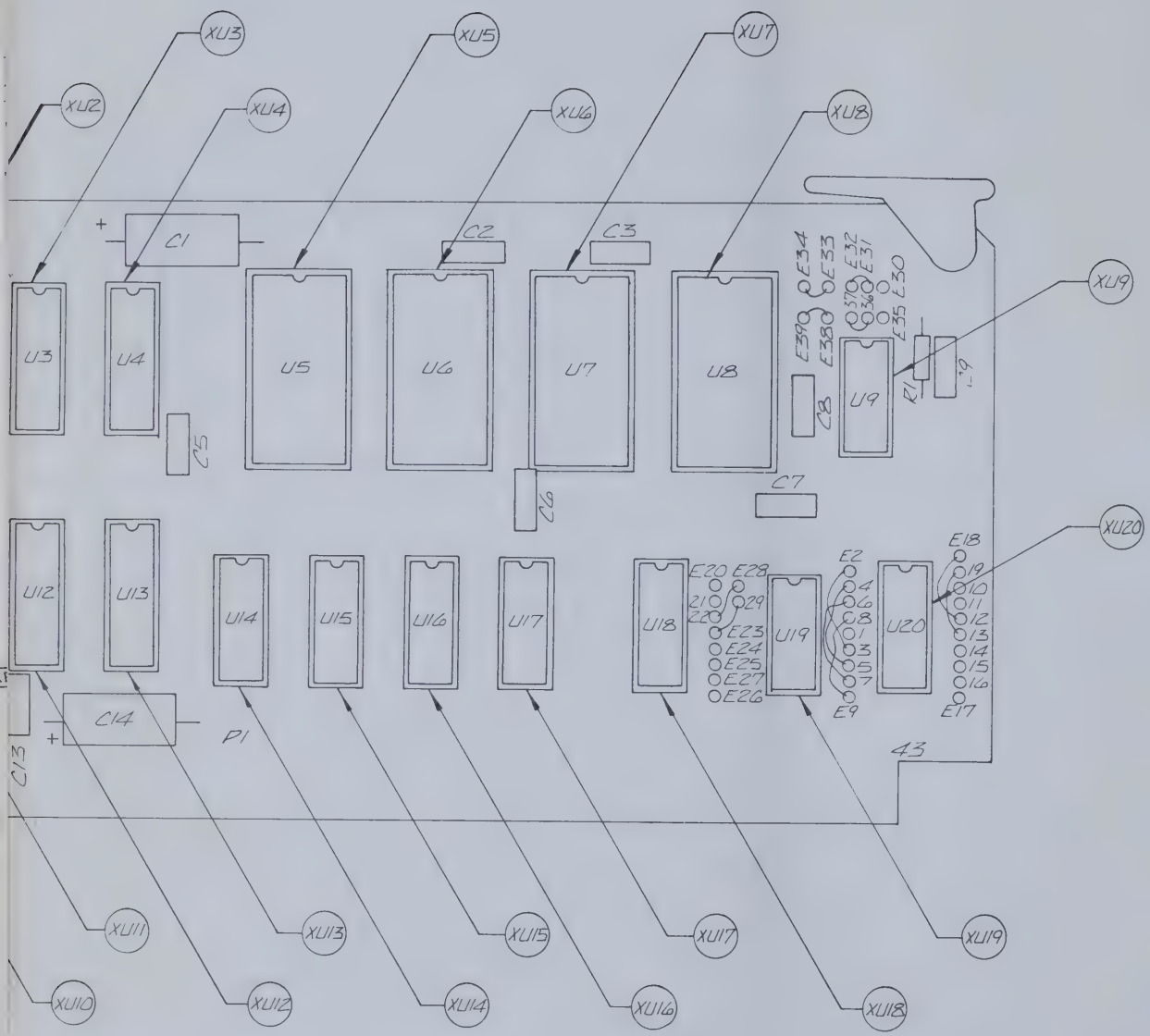


Figure 7-28. Main Memory (1) Printed Circuit Baord (A3A3), Schematic (Sheet 3 of 3)



APPLIES TO UNITS WITH SERIAL NUMBERS 401 AND BELOW (APPROXIMATELY)

Figure 7-29. Optional Memory (2) Printed Circuit Board (A3A4), Component Location



ITS WITH SERIAL NUMBERS 402 AND ABOVE (APPROXIMATELY)

Figure 7-29a. Optional Memory (2) Printed Circuit Board (A3A4), Component Location

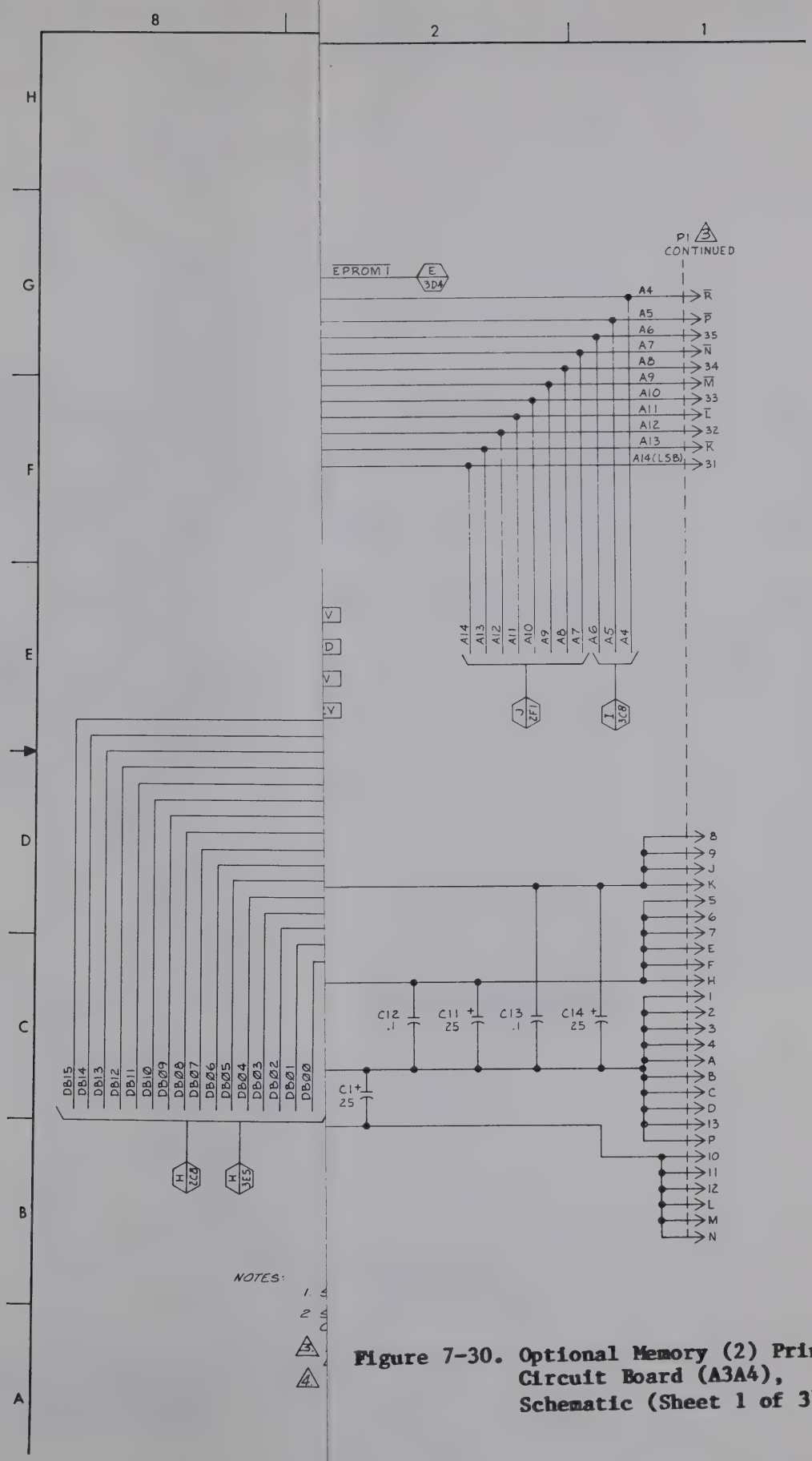
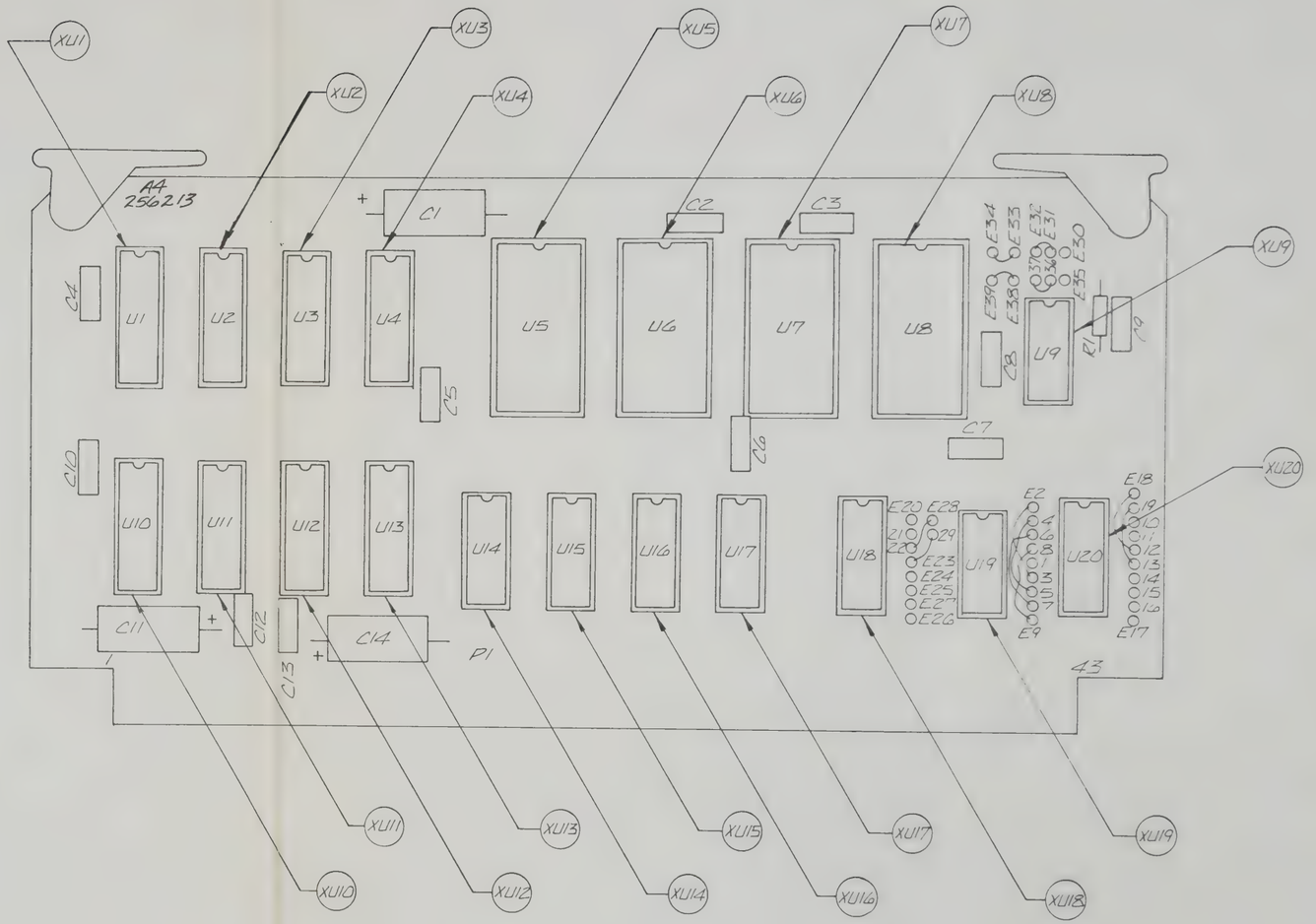
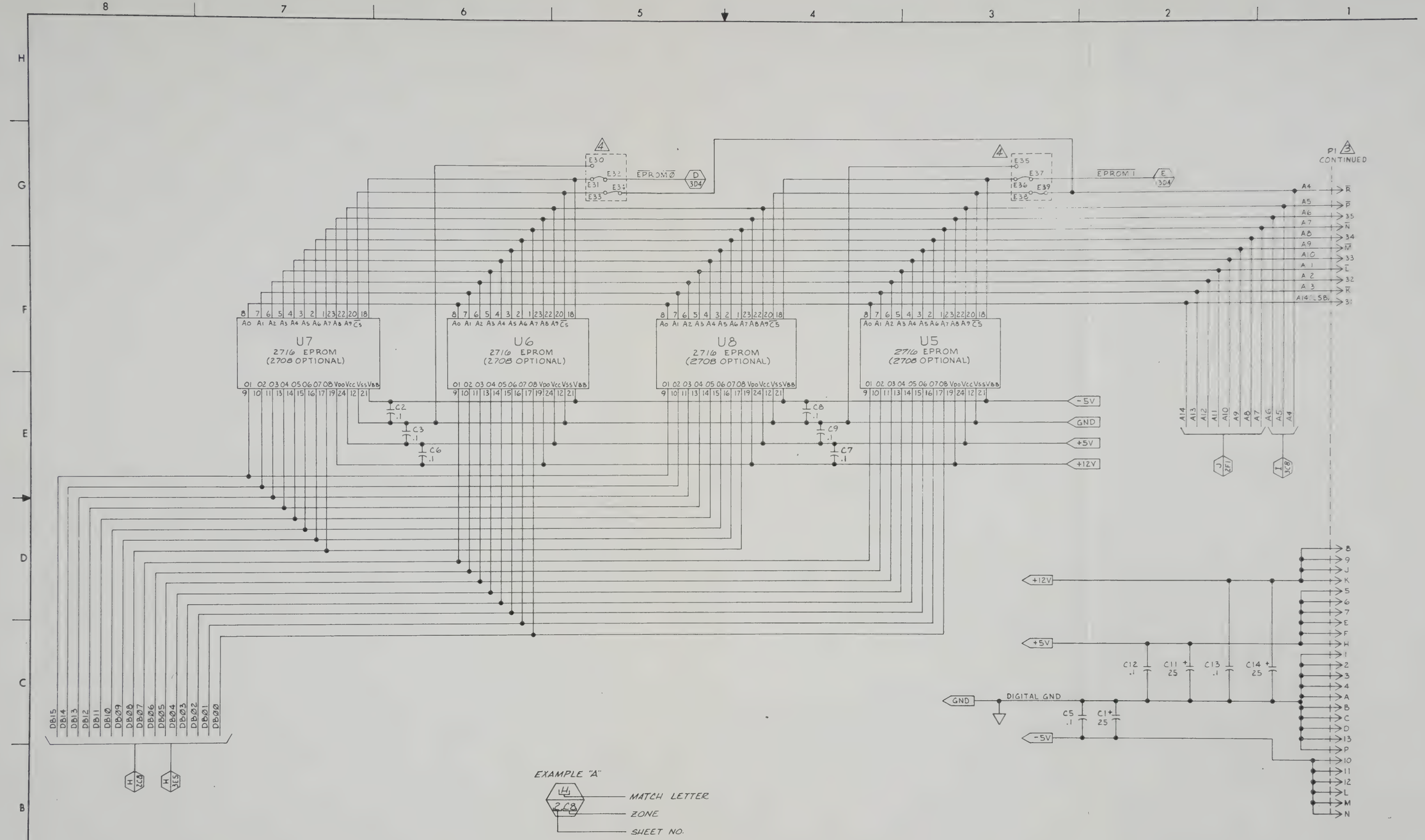


Figure 7-30. Optional Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 1 of 3)



APPLIES TO UNITS WITH SERIAL NUMBERS 402 AND ABOVE (APPROXIMATELY)

Figure 7-29a. Optional Memory (2) Printed Circuit Board (A3A4), Component Location



NOTES:

1. SEE NOTE 1 ON SHEET 2.
2. SEE EXAMPLE "A" FOR EXPLANATION OF CIRCUIT CONTINUATION FLAGS.
3. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
4. JUMPER ARRANGEMENT IS SHOWN FOR 2716 TYPE EPROM. FOR OPTIONAL EPROM TYPE 2708, ARRANGE JUMPERS: E1 TO E2, E3 TO E4, E5 TO E6, E7 TO E8, E30 TO E31, E32 TO E33, E35 TO E36, E37 TO E38.

Figure 7-30. Optional Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 1 of 3)

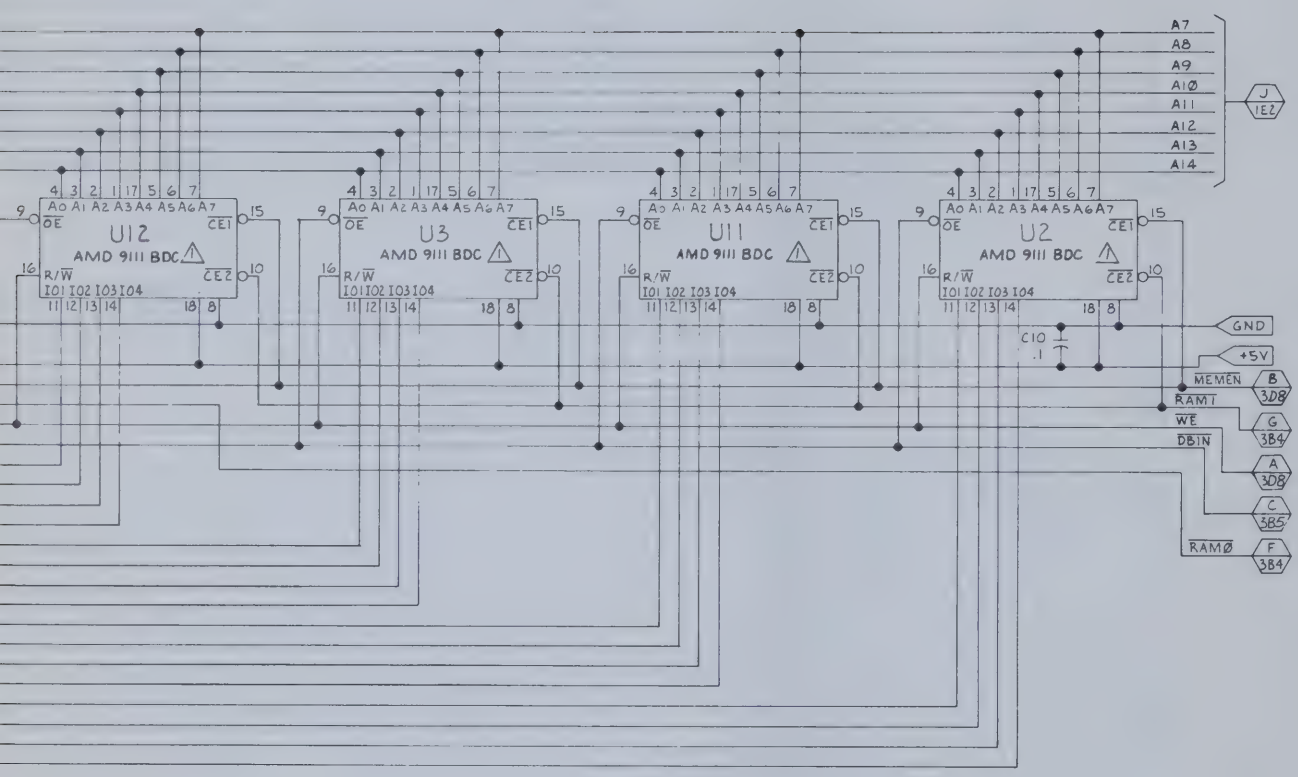


Figure 7-30. Optional Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 2 of 3)

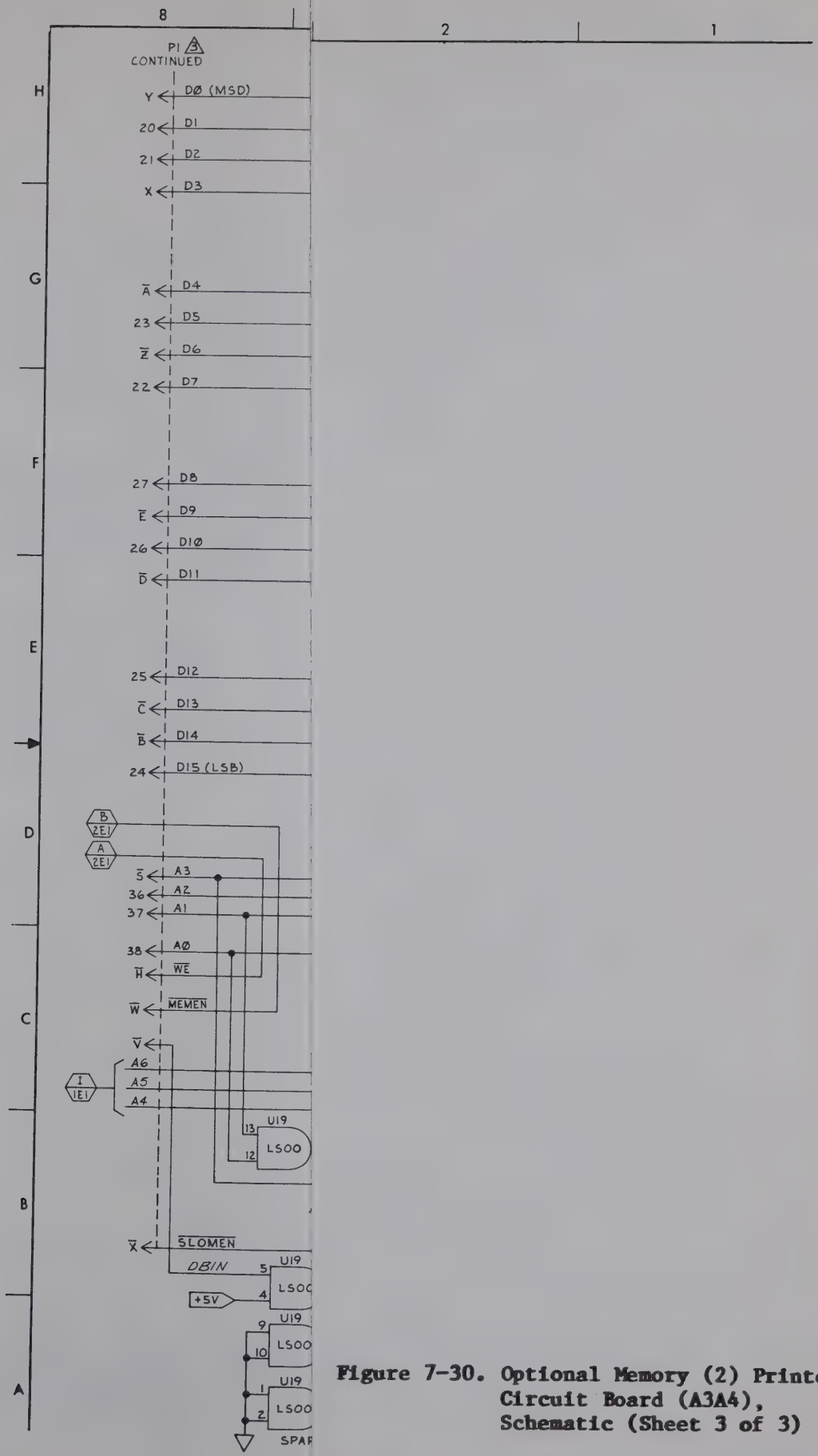


Figure 7-30. Optional Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 3 of 3)

164818C
41R038E

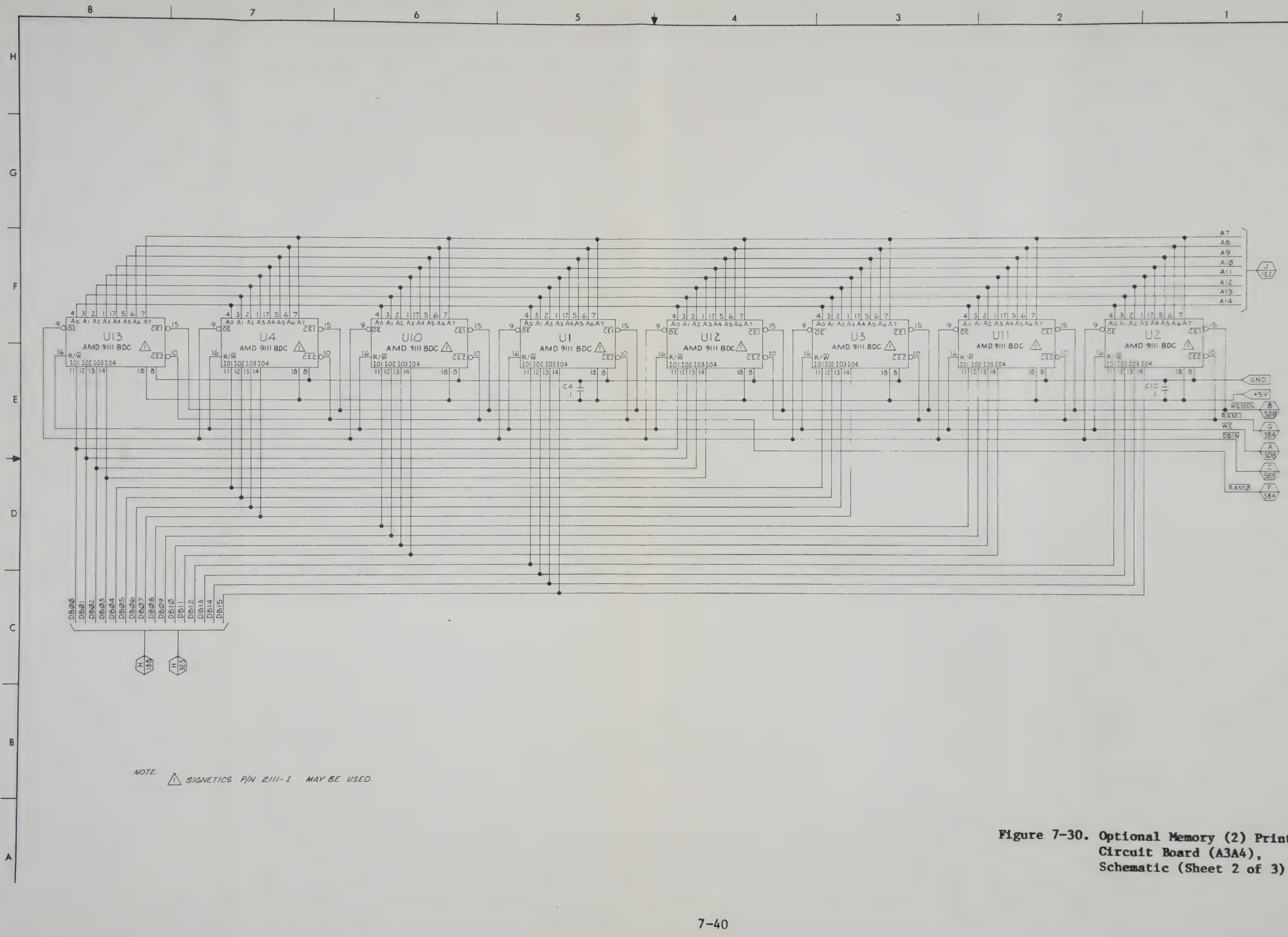
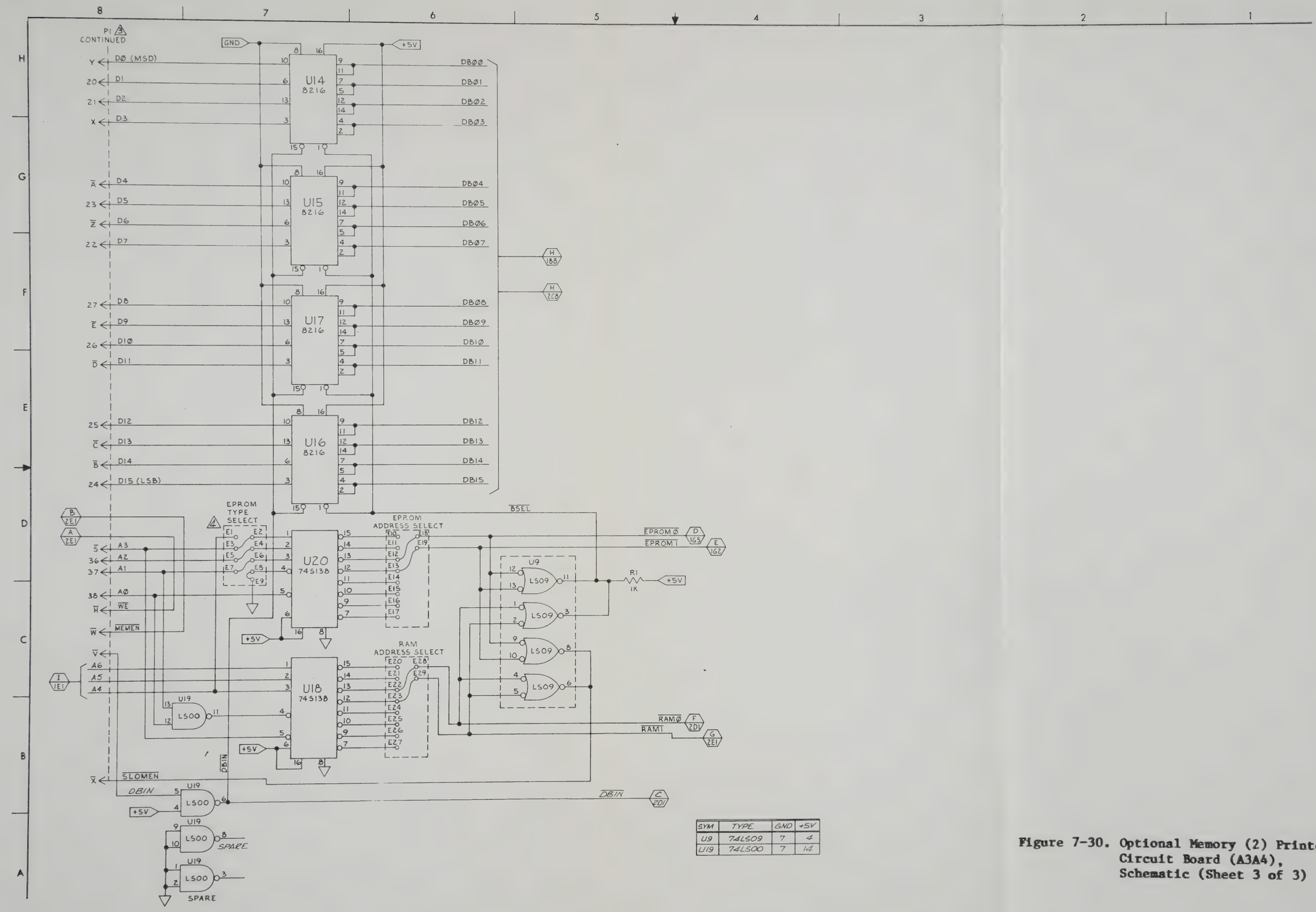


Figure 7-30. Optional Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 2 of 3)



SYM	TYPE	GND	+5V
U9	74LS09	7	4
U19	74LS00	7	14

Figure 7-30. Optional Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 3 of 3)

164818C
41R038E

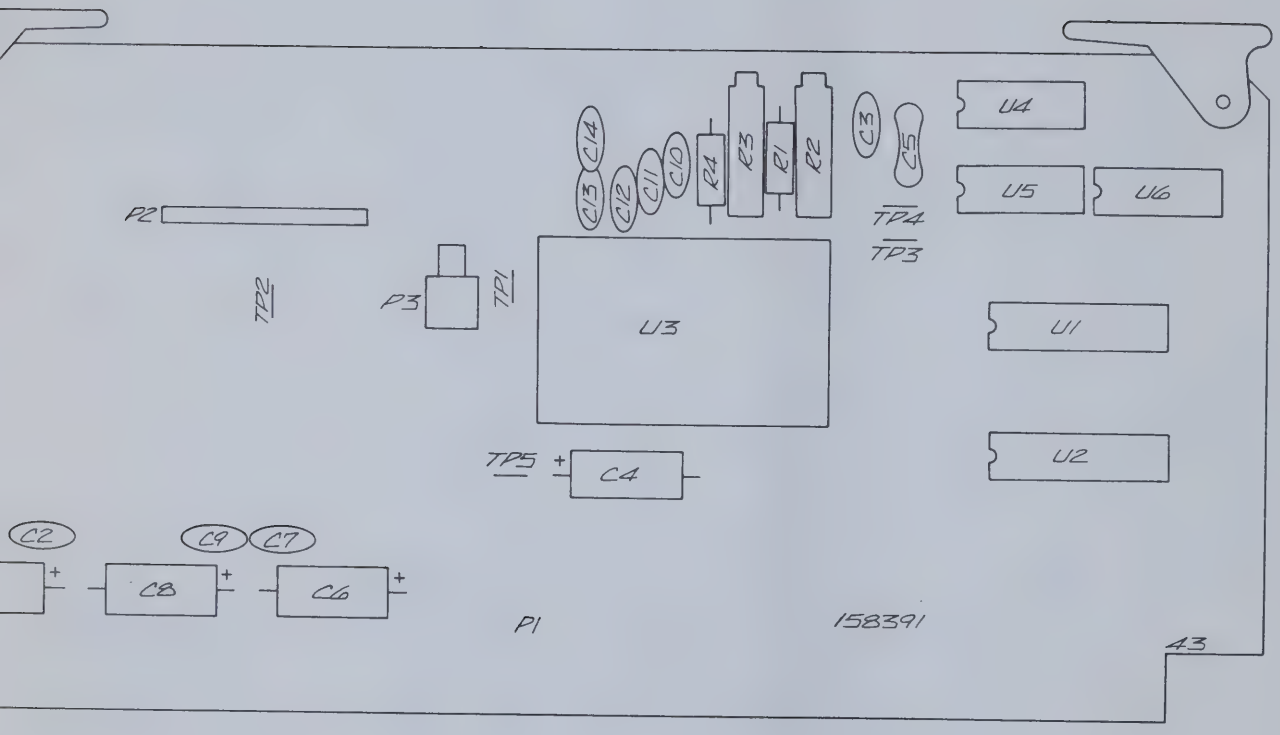


Figure 7-31. Optional CBA/DCA Interface Printed Circuit Board (A3A5), Component Location

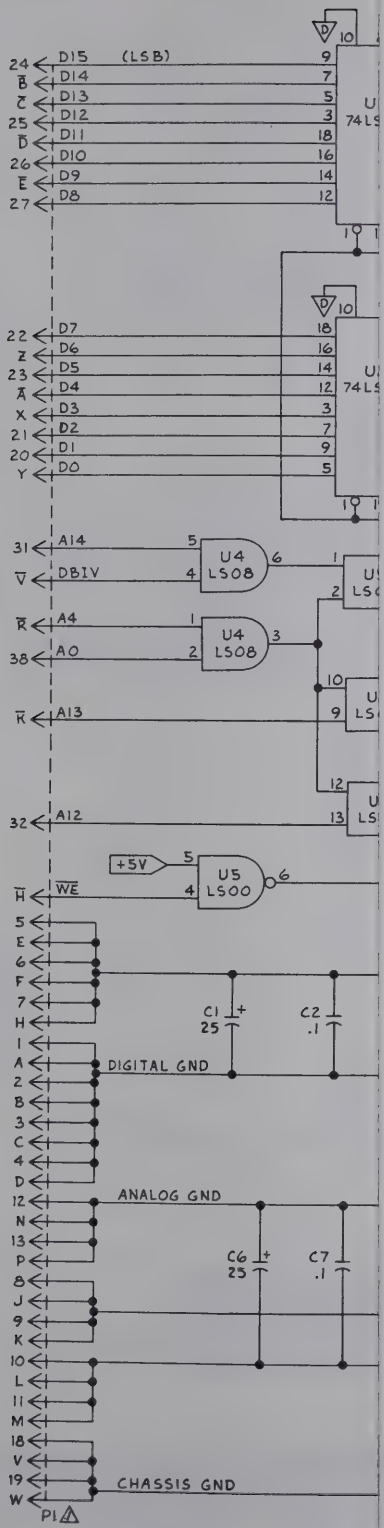


Figure 7-32. Optional CBA/DCA Interface Printed Circuit Board (A3A5), Schematic

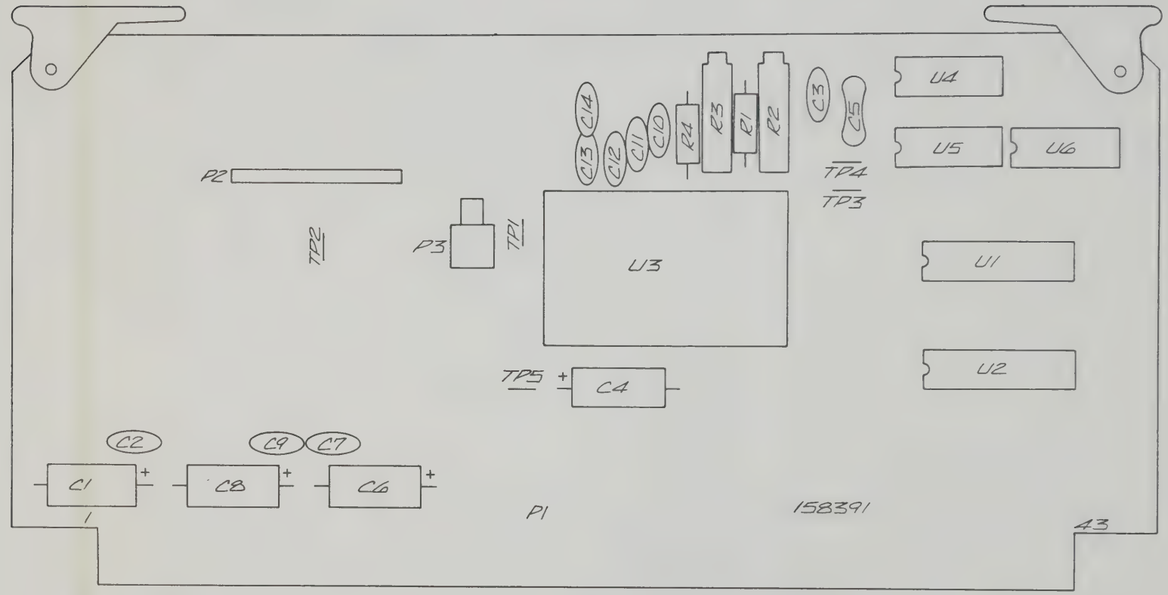
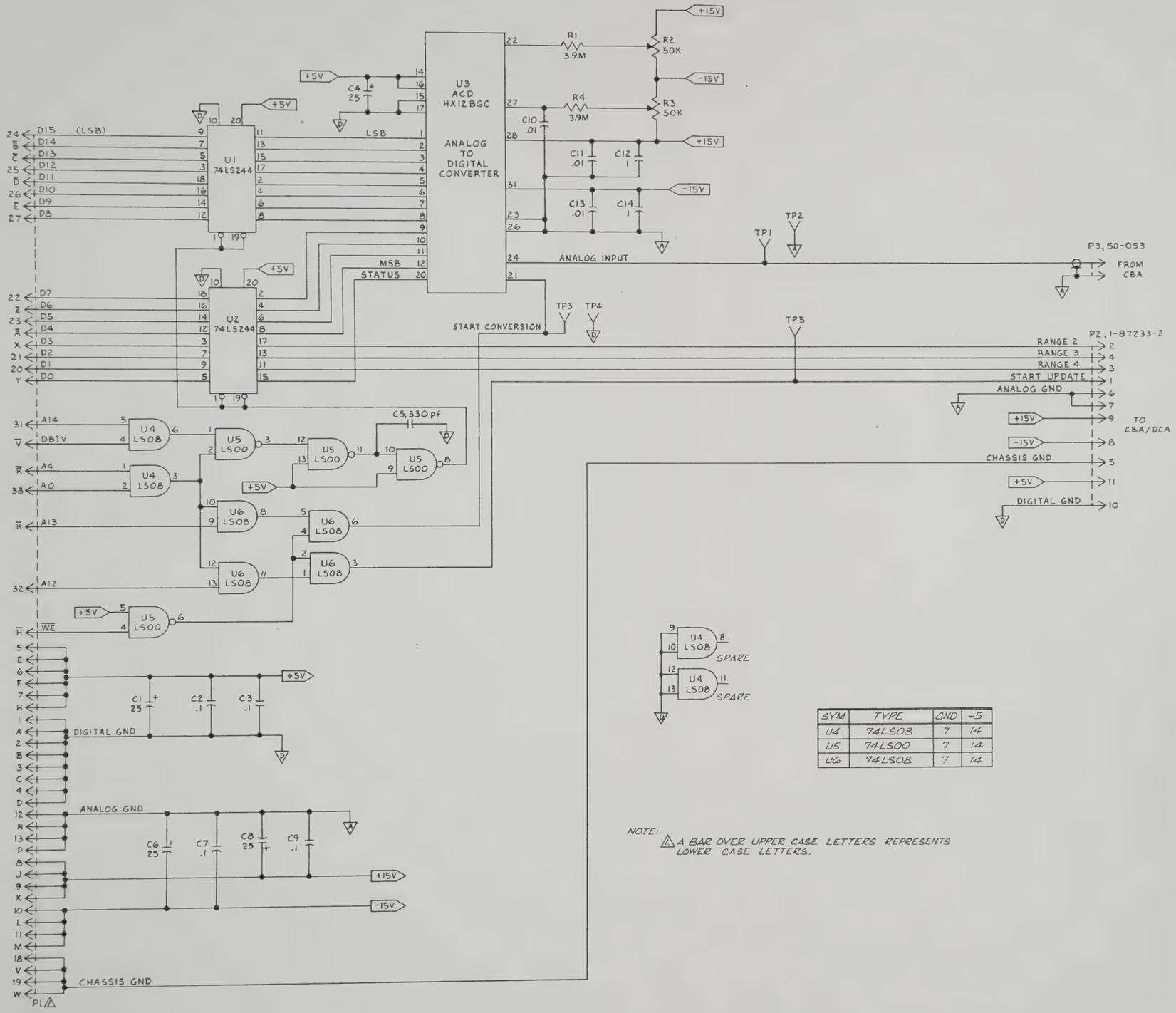


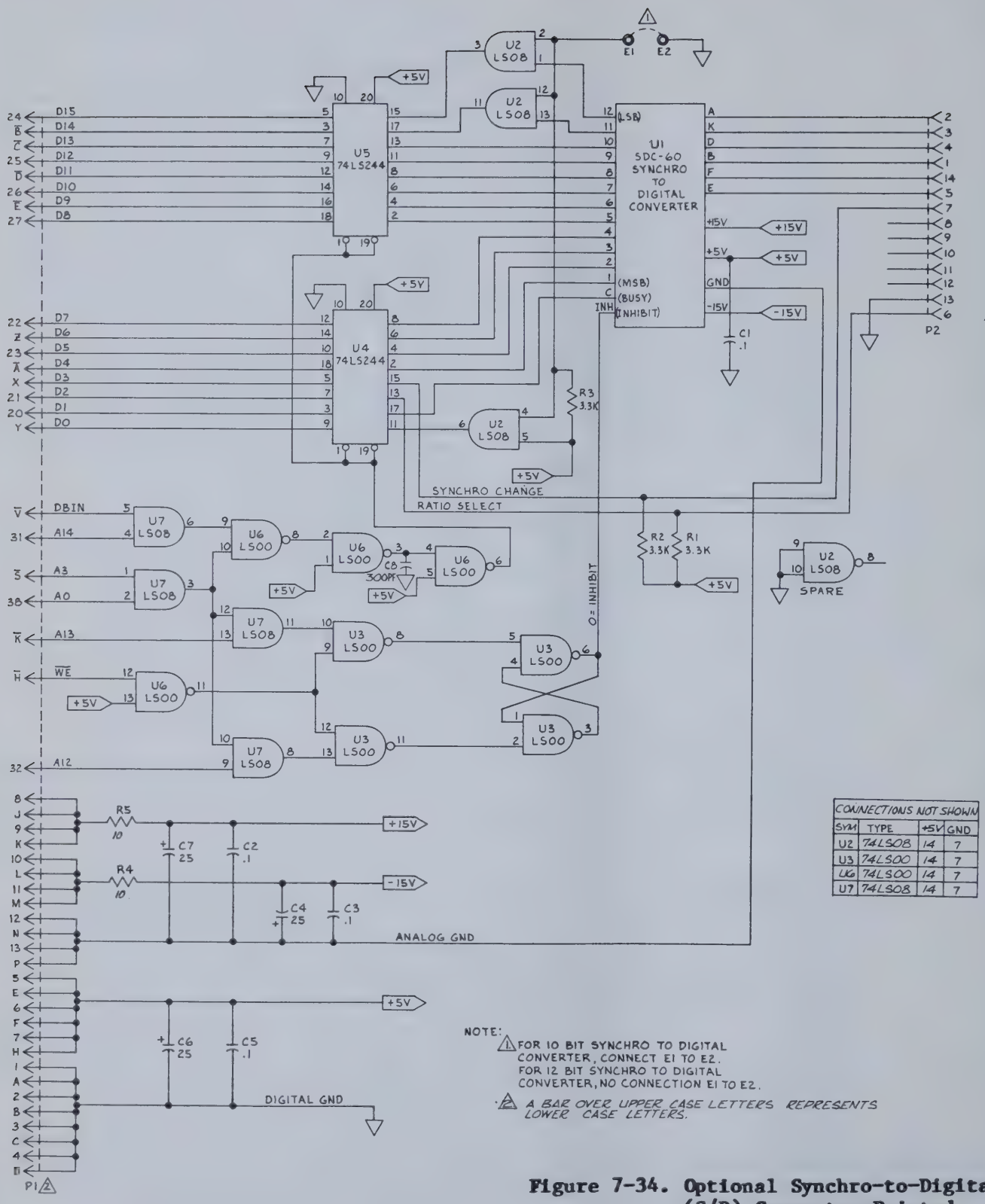
Figure 7-31. Optional CRA/DCA Interface Printed Circuit Board (A3A5), Component Location



SYM	TYPE	GND	+5
U4	74LS08	7	14
U5	74LS00	7	14
U6	74LS08	7	14

NOTE: ⚠ A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-32. Optional CBA/DCA Interface Printed Circuit Board (A3A5), Schematic



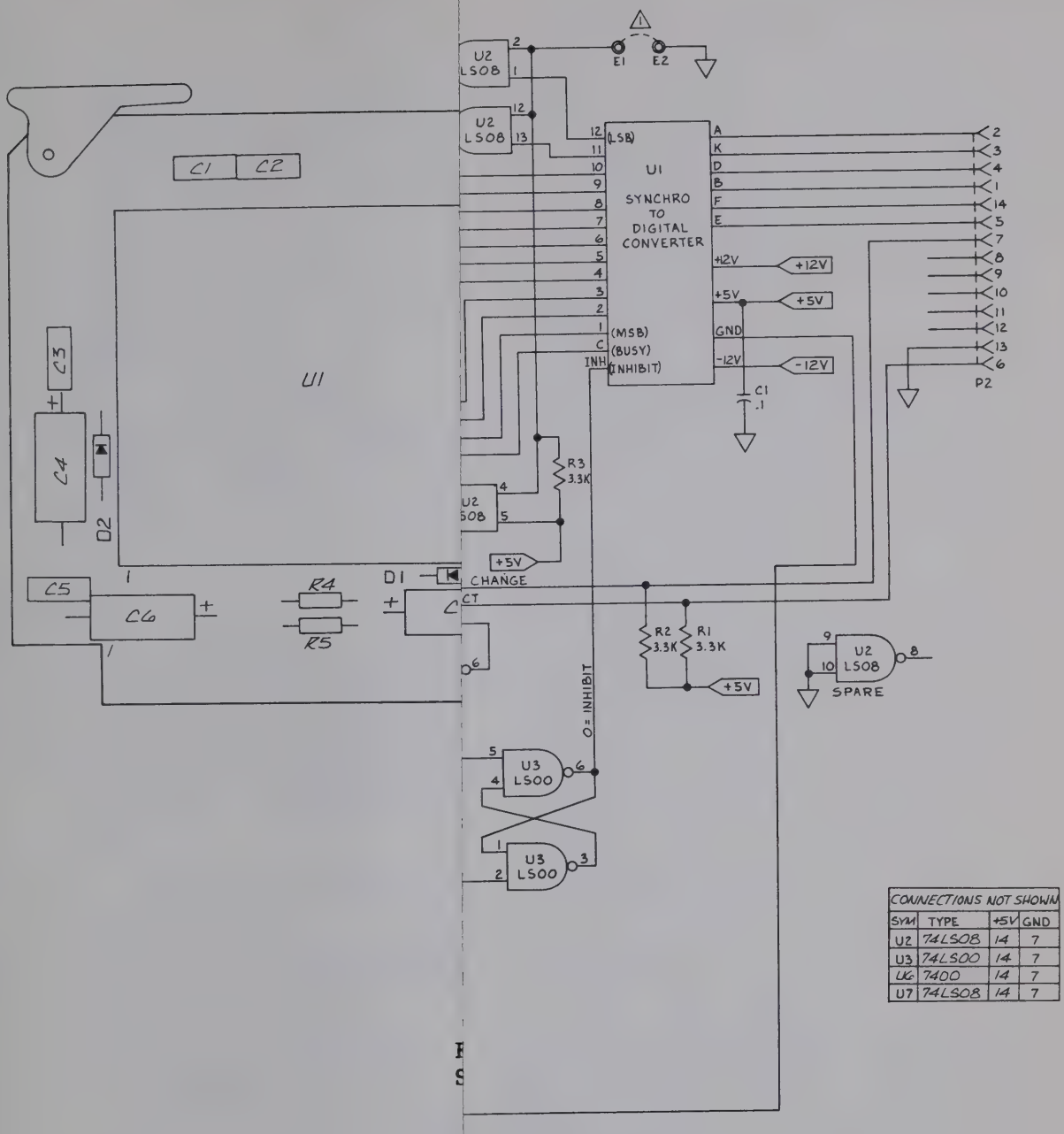
CONNECTIONS NOT SHOWN			
SYM	TYPE	+5V	GND
U2	74LS08	14	7
U3	74LS00	14	7
U6	74LS00	14	7
U7	74LS08	14	7

NOTE:

1. FOR 10 BIT SYNCHRO TO DIGITAL CONVERTER, CONNECT E1 TO E2. FOR 12 BIT SYNCHRO TO DIGITAL CONVERTER, NO CONNECTION E1 TO E2.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-34. Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Schematic

162956B

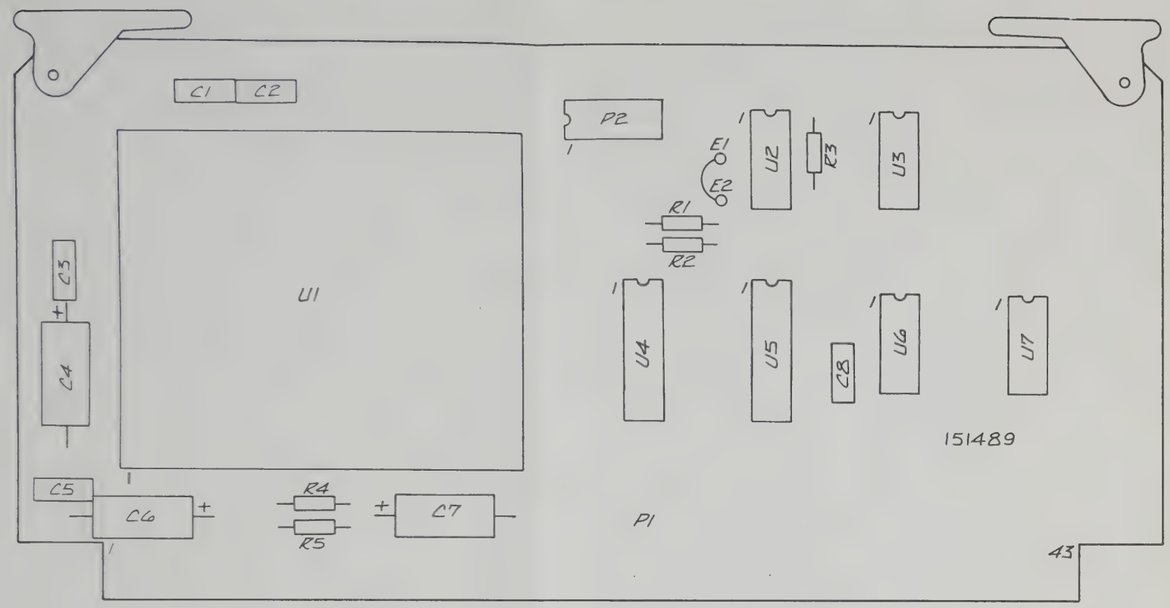


CONNECTIONS NOT SHOWN			
SYM	TYPE	+5V	GND
U2	74LS08	14	7
U3	74LS00	14	7
U6	7400	14	7
U7	74LS08	14	7

NOTE:
1. FOR 10 BIT SYNCHRO TO DIGITAL CONVERTER, CONNECT E1 TO E2. FOR 12 BIT SYNCHRO TO DIGITAL CONVERTER, NO CONNECTION E1 TO E2.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-33a. Optional Synchro-(S/D) Converter P Circuit Board (A3 Component Locatio

Figure 7-34a. Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Schematic

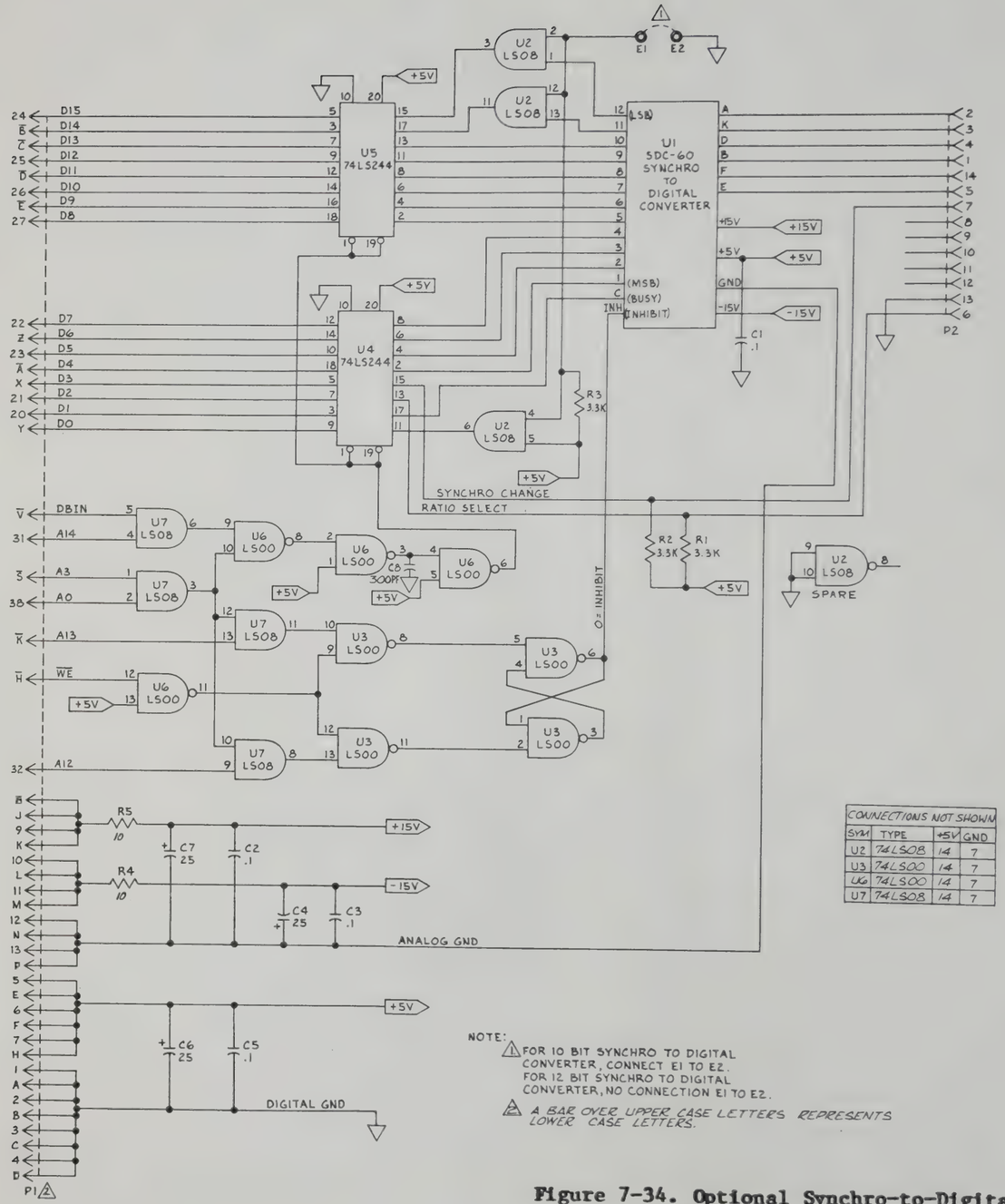


FIGURES 7-33 AND 7-34 APPLY TO UNITS WITH SERIAL NUMBERS 324 AND BELOW (APPROXIMATELY)

Figure 7-33. Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Component Location

151489D

41R038E

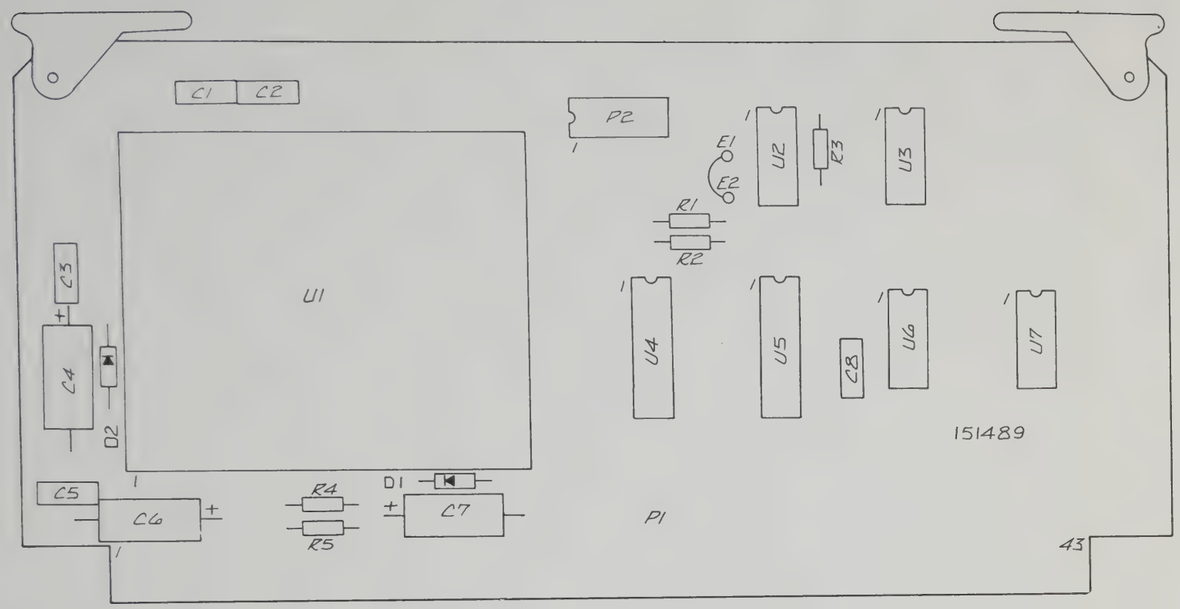


CONNECTIONS NOT SHOWN			
SYM	TYPE	+5V	GND
U2	74LS08	14	7
U3	74LS00	14	7
U6	74LS00	14	7
U7	74LS08	14	7

NOTE:
1. FOR 10 BIT SYNCHRO TO DIGITAL CONVERTER, CONNECT E1 TO E2. FOR 12 BIT SYNCHRO TO DIGITAL CONVERTER, NO CONNECTION E1 TO E2.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-34. Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Schematic

162956B

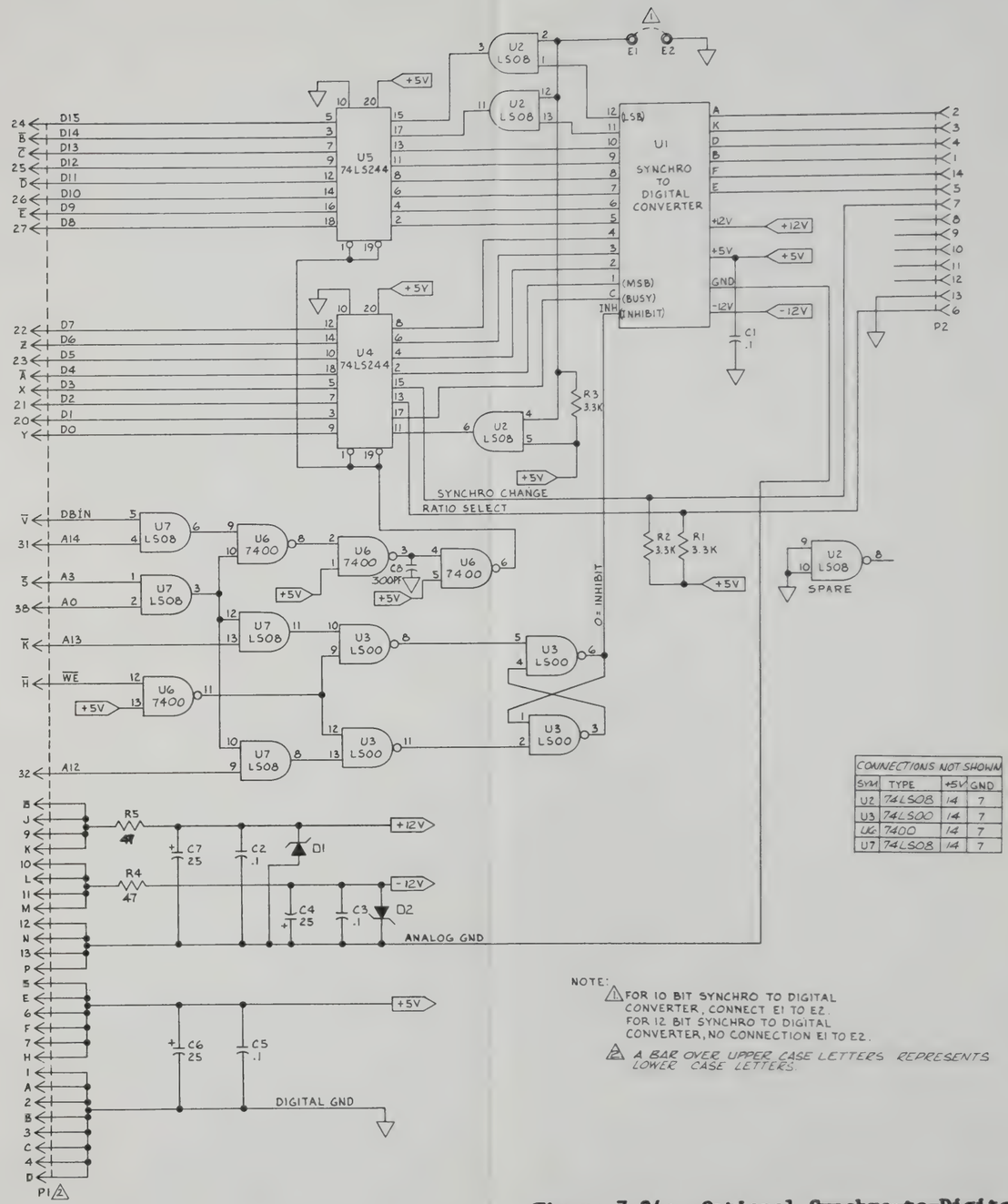


FIGURES 7-33A AND 7-34A APPLY TO UNITS WITH SERIAL NUMBERS 325 AND ABOVE (APPROXIMATELY)

Figure 7-33a. Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Component Location

151489H

41R038E



CONNECTIONS NOT SHOWN			
SYM	TYPE	+5V	GND
U2	74LS08	14	7
U3	74LS00	14	7
U6	7400	14	7
U7	74LS08	14	7

NOTE:

⚠ FOR 10 BIT SYNCHRO TO DIGITAL CONVERTER, CONNECT E1 TO E2. FOR 12 BIT SYNCHRO TO DIGITAL CONVERTER, NO CONNECTION E1 TO E2.

⚠ A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-34a. Optional Synchro-to-Digital (S/D) Converter Printed Circuit Board (A3A6), Schematic

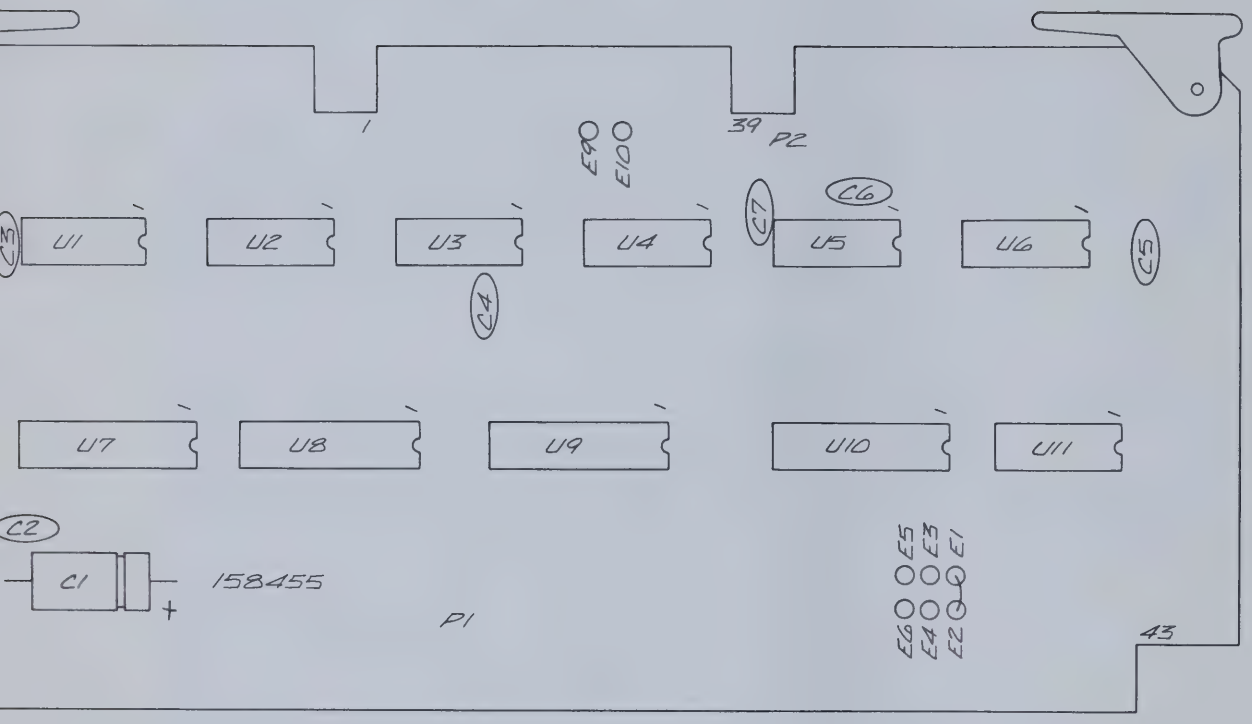


Figure 7-35. Optional Digital Interface Printed Circuit Board (A3A5 and/or A3A6), Component Location

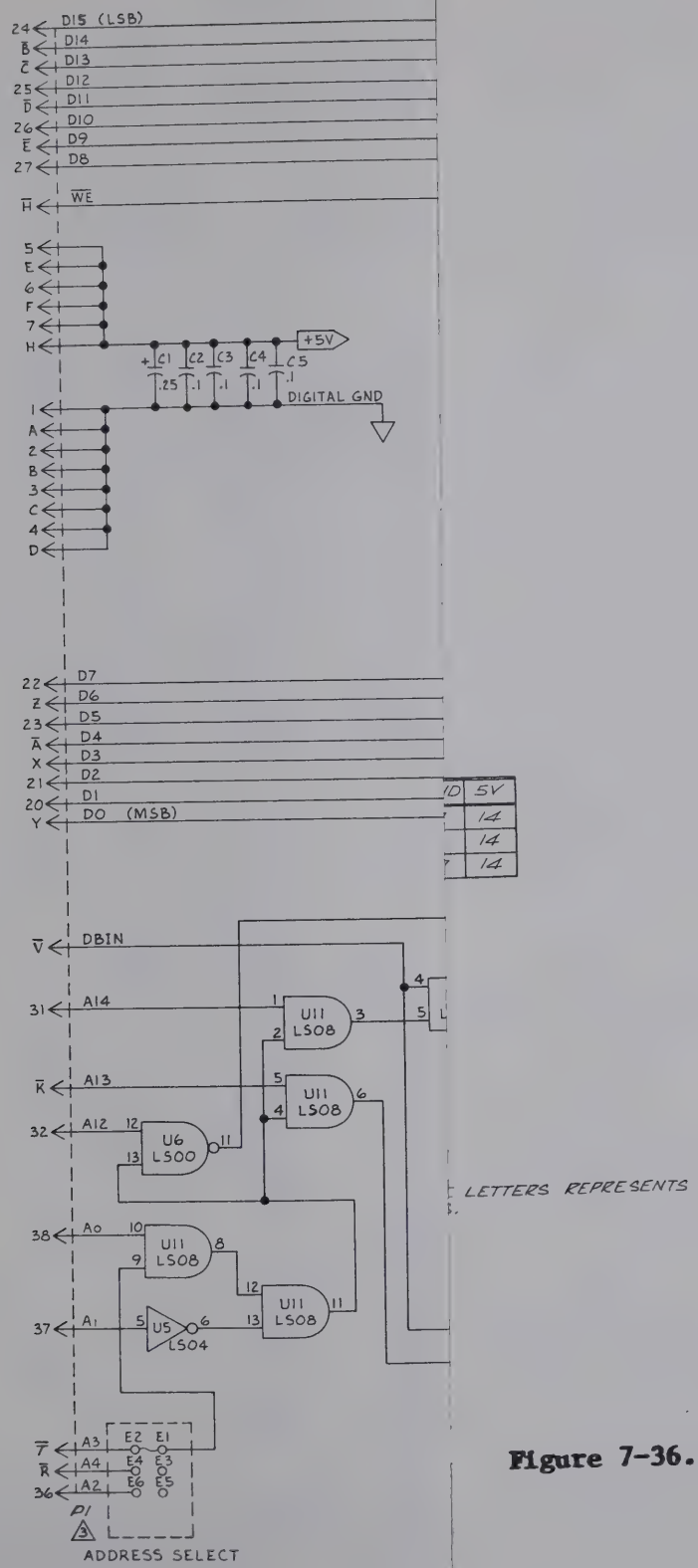


Figure 7-36. Optional Digital Interface Printed Circuit Board (A3A5 and/or A3A6), Schematic

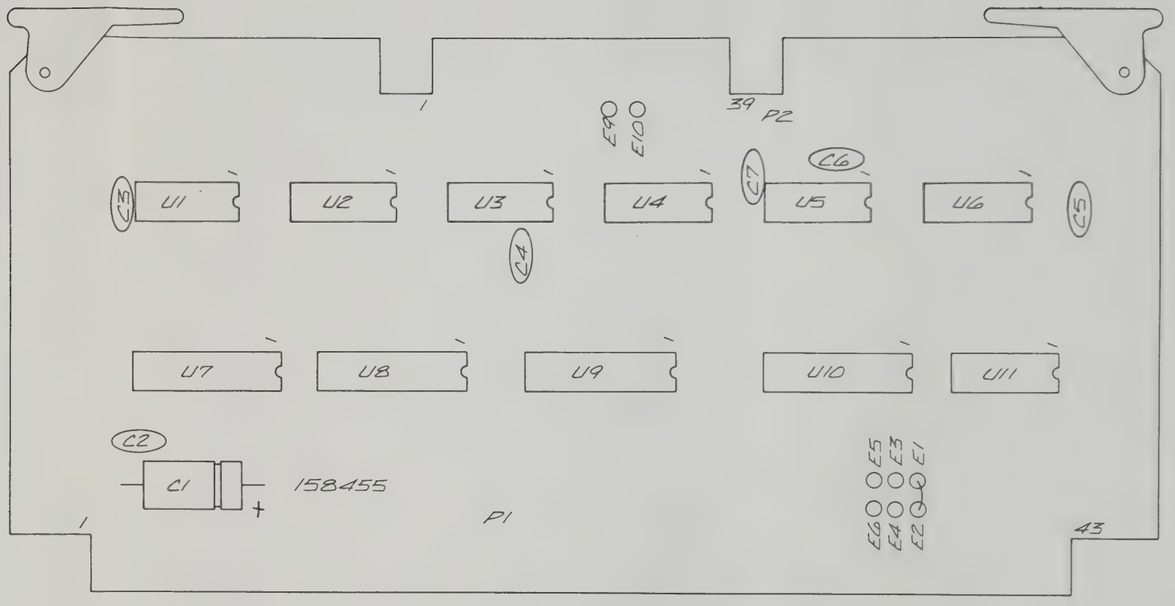
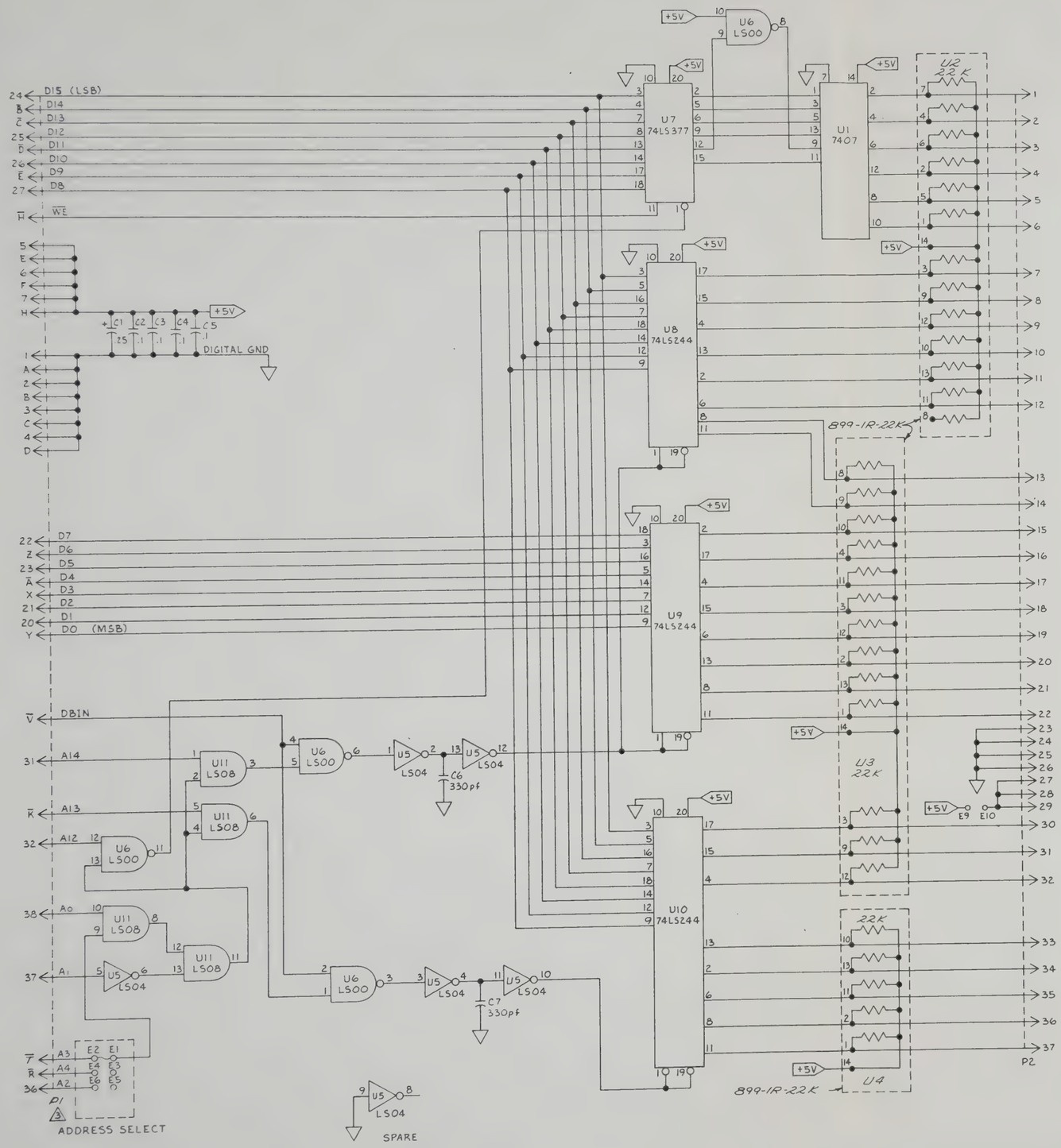


Figure 7-35. Optional Digital Interface Printed Circuit Board (A3A5 and/or A3A6), Component Location

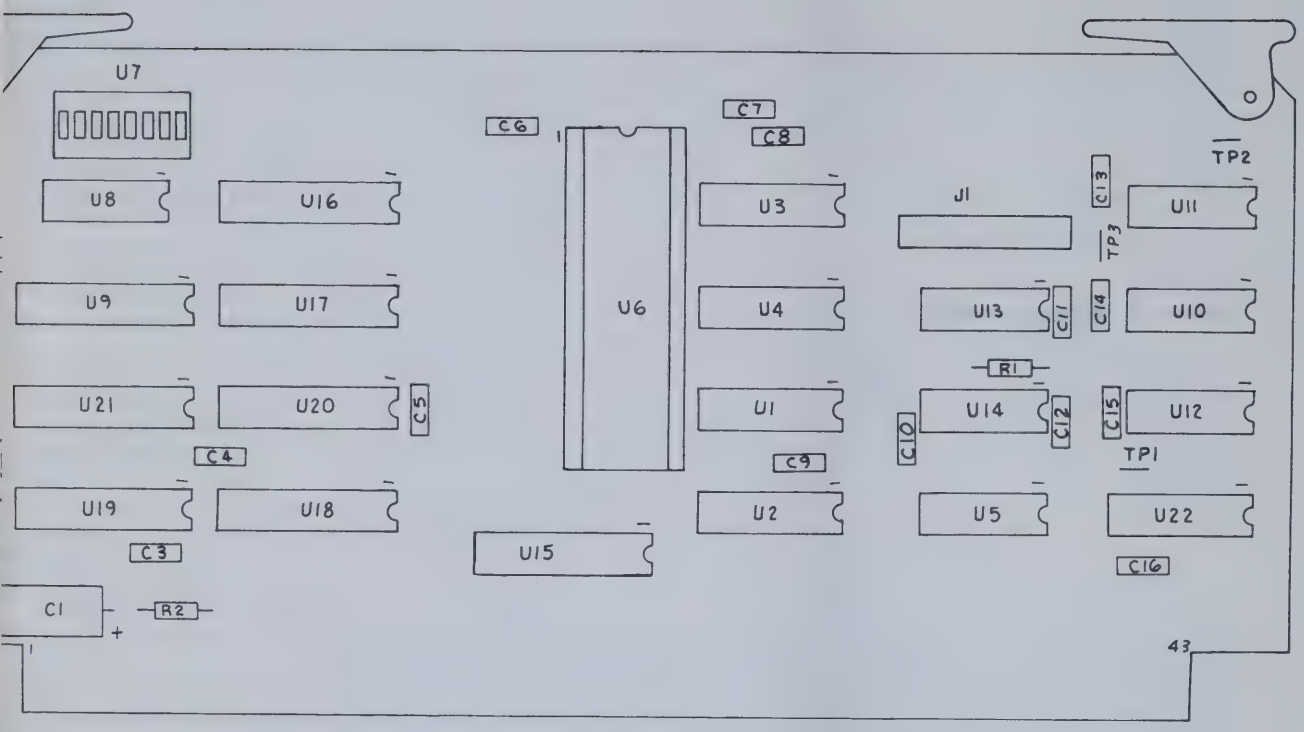


SYM	TYPE	GND	5V
U5	74LS04	7	14
U6	74LS00	7	14
U11	74LS08	7	14

NOTE:
1. E9 AND E10 NOT CONNECTED. FOR FUTURE USE ONLY.
2. E7 & E8 NOT USED.
3. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.

Figure 7-36. Optional Digital Interface Printed Circuit Board (A3A5 and/or A3A6), Schematic

158453A
41R038E



APPLIES TO UNITS WITH SERIAL NUMBERS 349 AND BELOW (APPROXIMATELY)

Figure 7-37. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Component Location

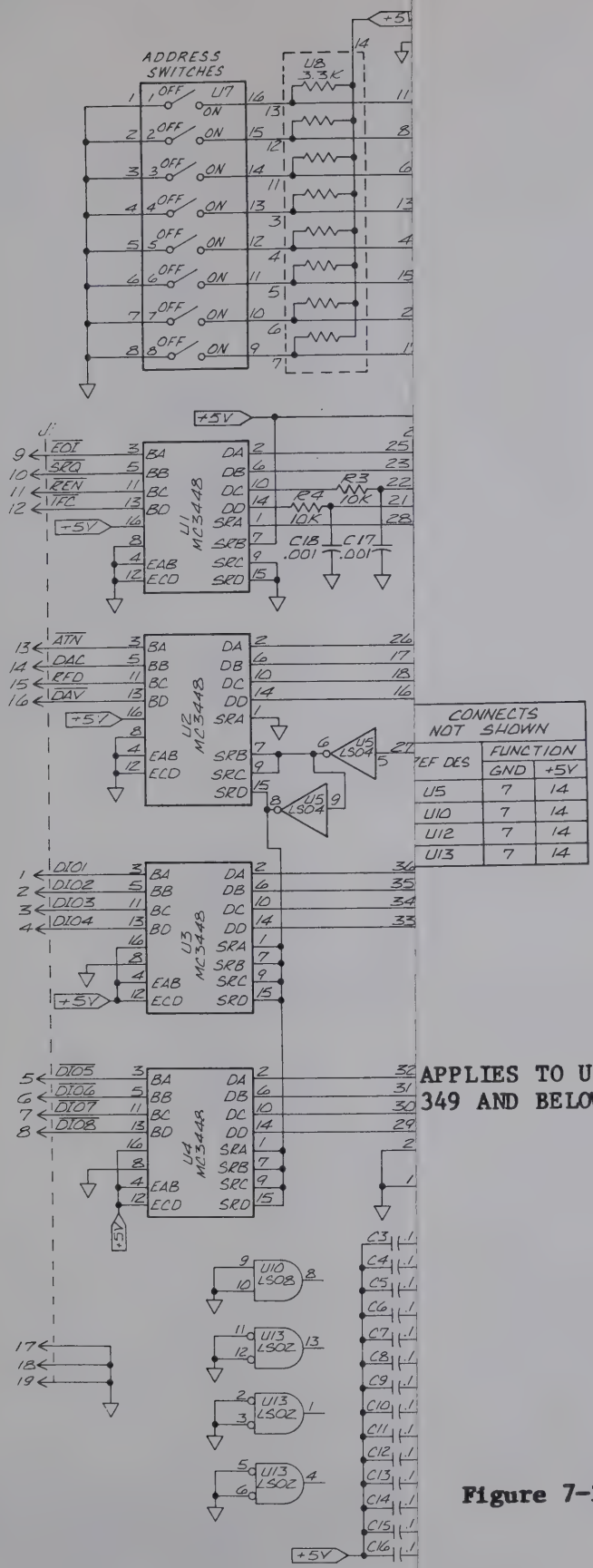
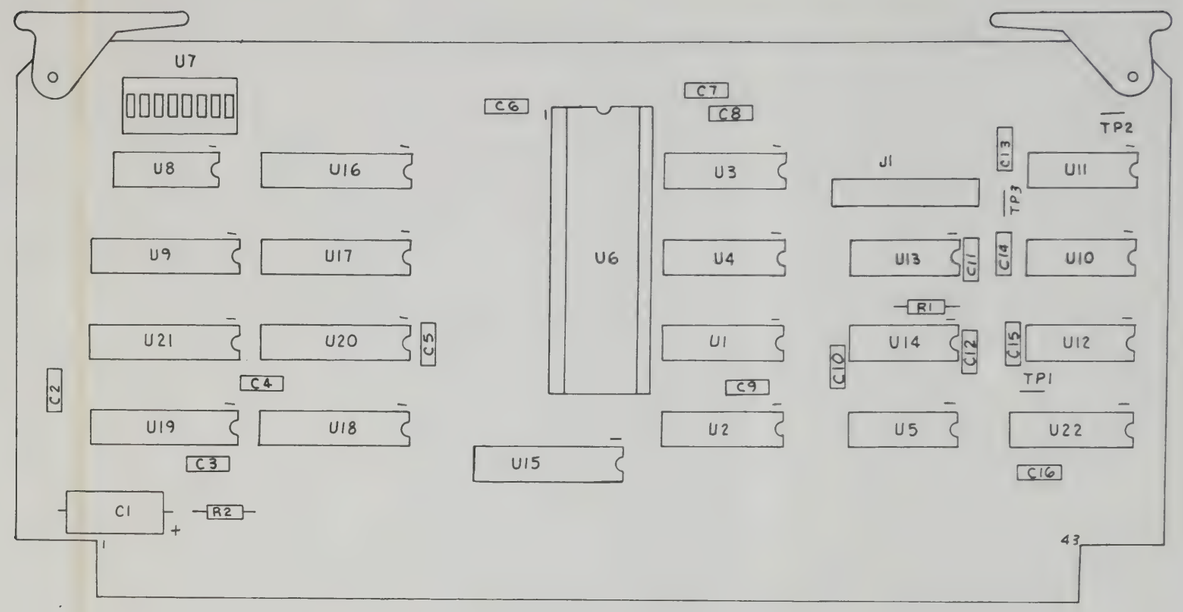


Figure 7-38. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic



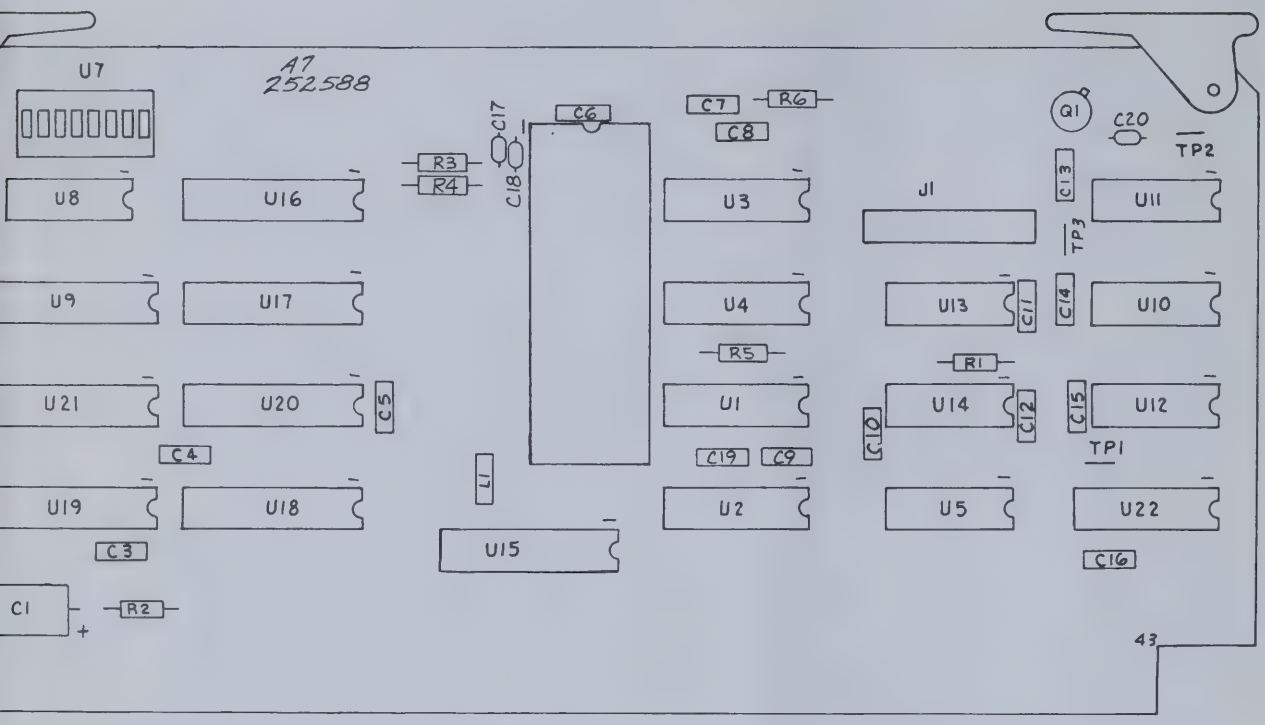
APPLIES TO UNITS WITH SERIAL NUMBERS 349 AND BELOW (APPROXIMATELY)

Figure 7-37. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Component Location

CONNECTS NOT SHOWN		
REF DES	FUNCTION	
	GND	+5V
U5	7	14
U10	7	14
U12	7	14
U13	7	14

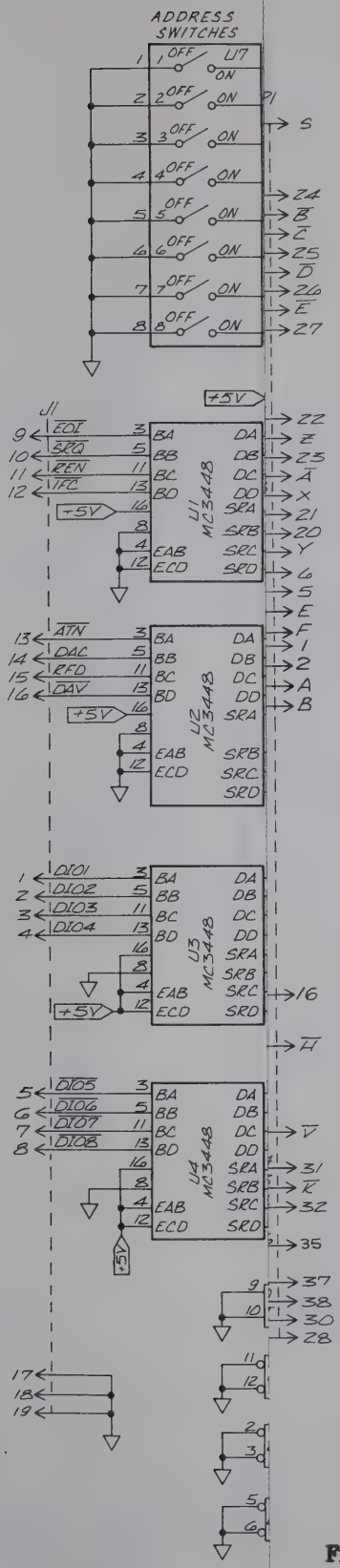
APPLIES TO UNITS WITH SERIAL NUMBERS 349 AND BELOW (APPROXIMATELY)

Figure 7-38. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic



APPLIES TO UNITS WITH SERIAL NUMBERS 350 AND ABOVE (APPROXIMATELY)

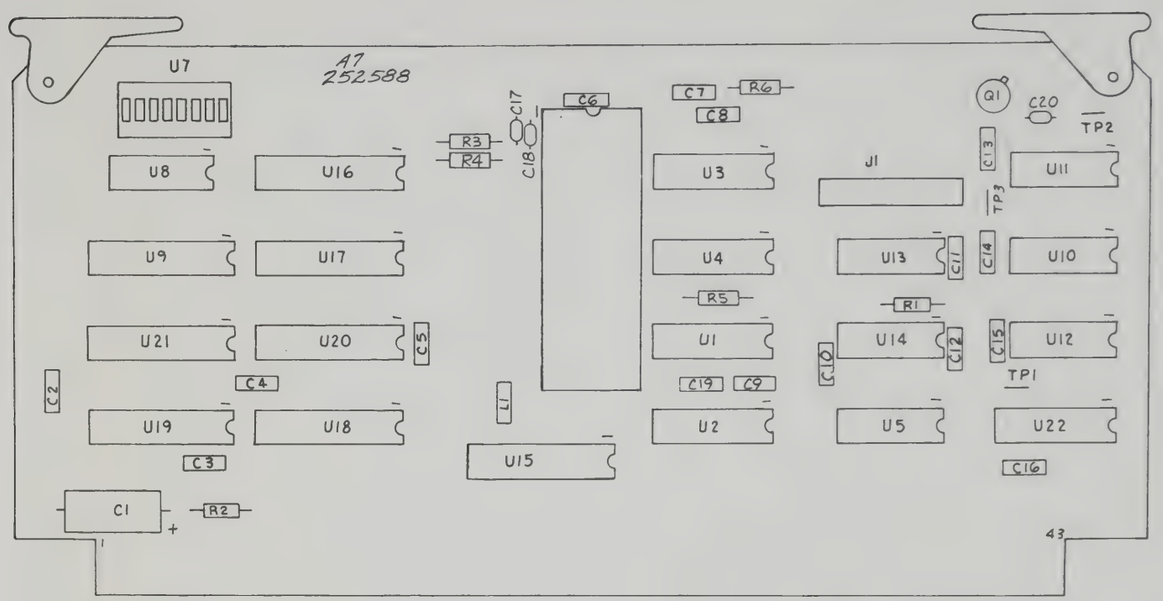
Figure 7-37a. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Component Location



CONNECTS NOT SHOWN		
REF DES	FUNCTION	
	GND	+5V
U5	7	14
U10	7	14
U12	7	14
U13	7	14

APPLIES TO UNITS WITH SERIAL NUMBERS 350 AND ABOVE (APPROXIMATELY)

Figure 7-38a. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic



APPLIES TO UNITS WITH SERIAL NUMBERS 350 AND ABOVE (APPROXIMATELY)

Figure 7-37a. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Component Location

CONNECTS NOT SHOWN		
REF DES	FUNCTION	
	GND	+5V
U5	7	14
U10	7	14
U12	7	14
U13	7	14

APPLIES TO UNITS WITH SERIAL NUMBERS 350 AND ABOVE (APPROXIMATELY)

Figure 7-38a. Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic

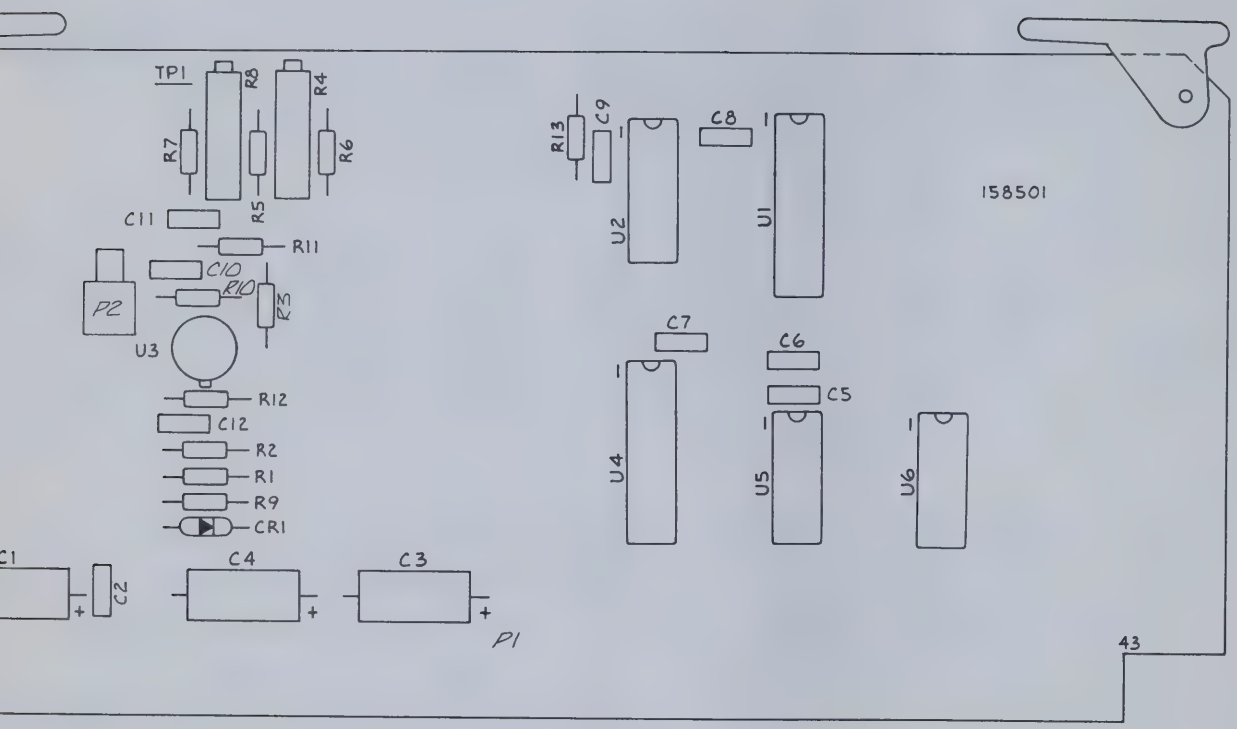


Figure 7-39. 60 dB Option Printed Circuit Board (A3A8), Component Location

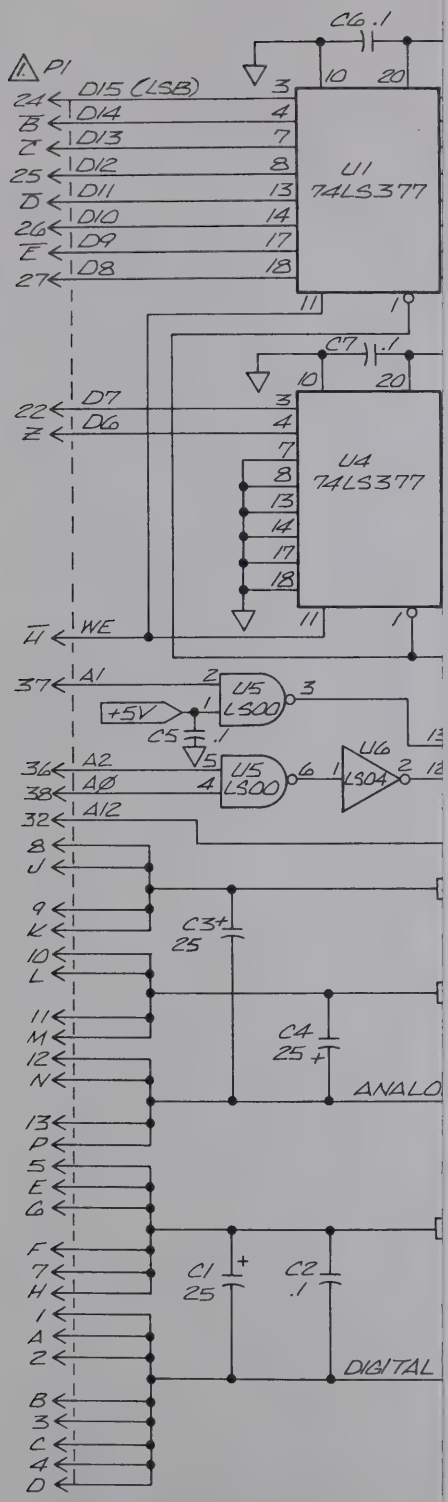


Figure 7-40. 60 dB Option Printed Circuit Board (A3A8), Schematic

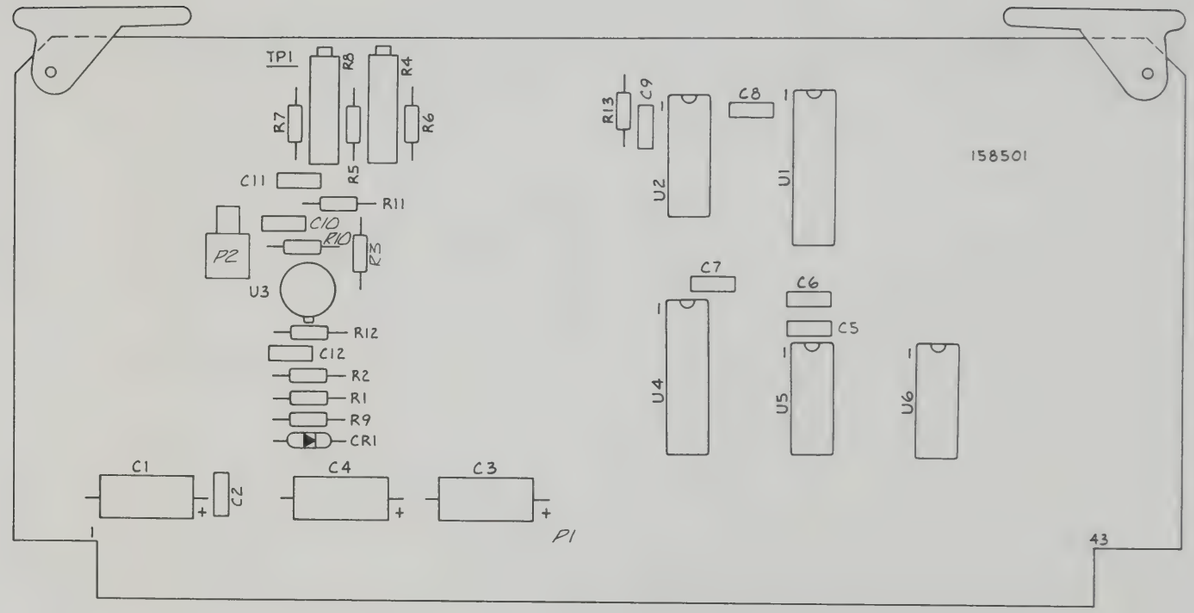
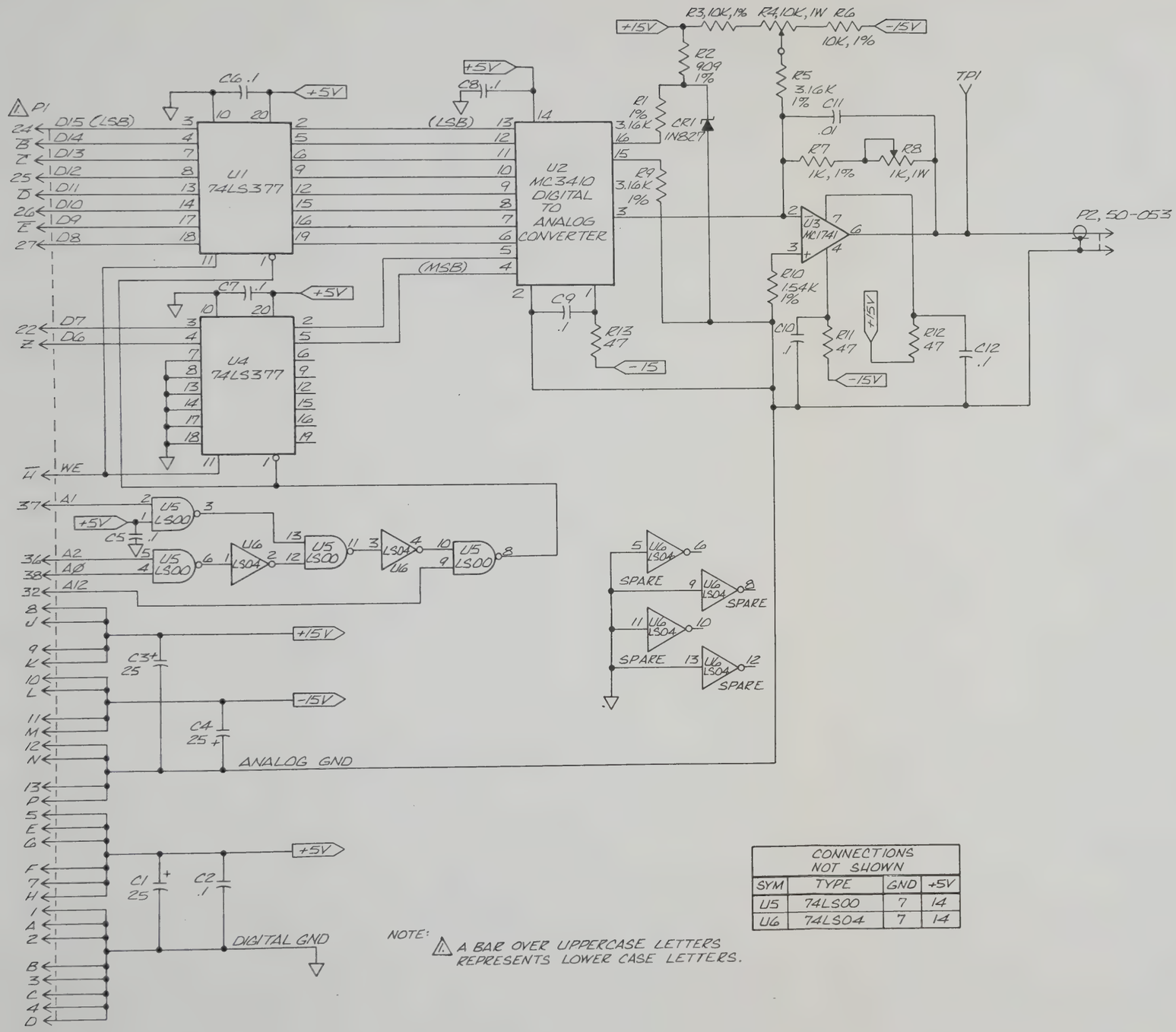


Figure 7-39. 60 dB Option Printed Circuit Board (A3A8), Component Location



NOTE: ⚠ A BAR OVER UPPERCASE LETTERS REPRESENTS LOWER CASE LETTERS.

CONNECTIONS NOT SHOWN			
SYM	TYPE	GND	+5V
U5	74LS00	7	14
U6	74LS04	7	14

Figure 7-40. 60 dB Option Printed Circuit Board (A3A8), Schematic

158499A
41R038E

7-53/7-54

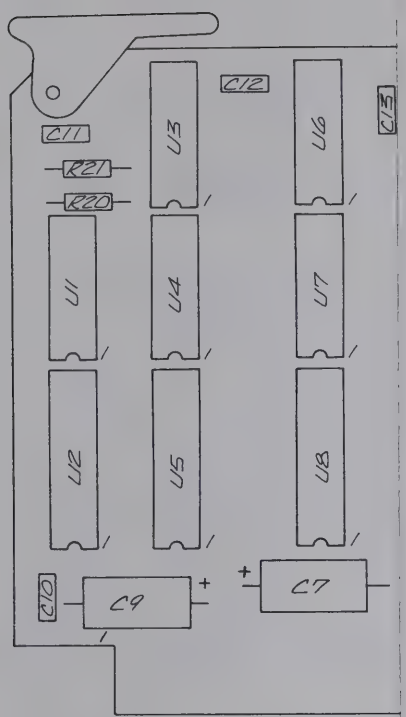


Figure 7-41. Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Component Location

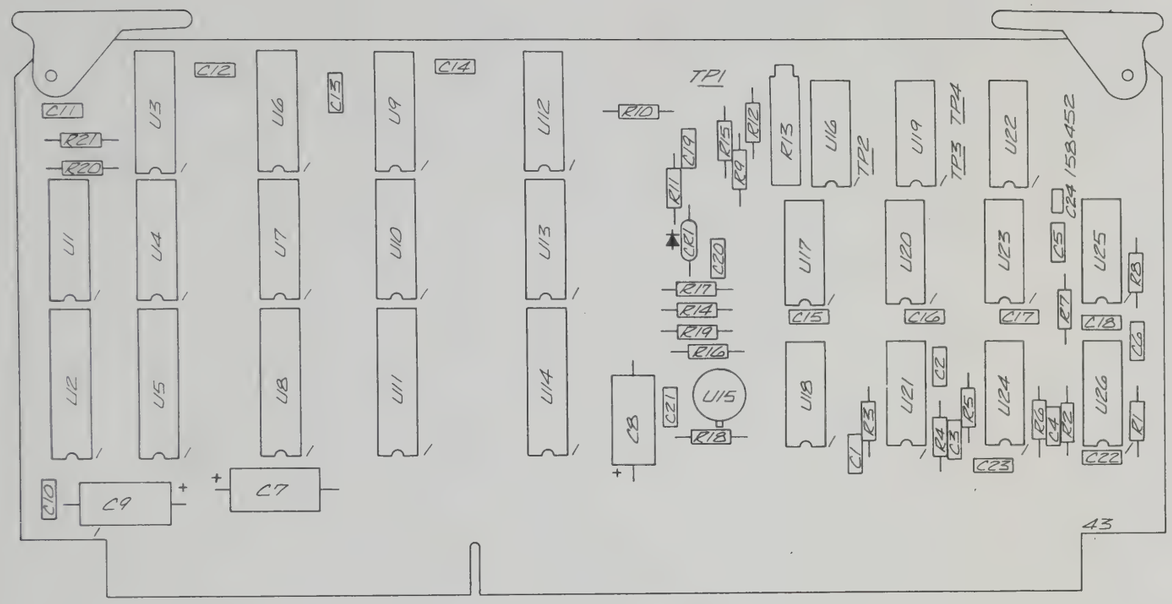
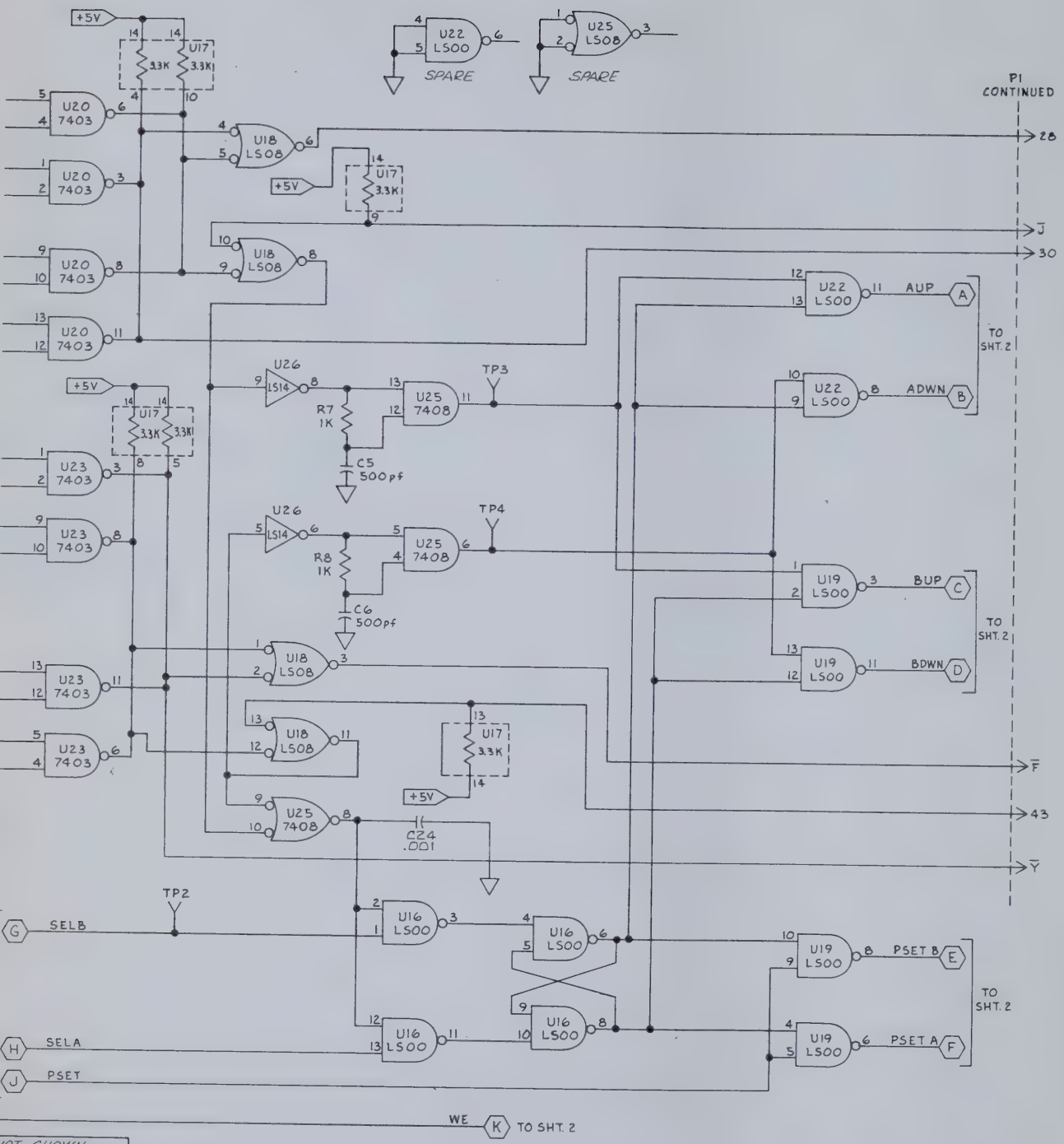


Figure 7-41. Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Component Location



NOT SHOWN		
	GND	+5V
	7	14
	7	14
	7	14
	7	14
	7	14
	7	14
	7	14
	7	14
	7	14

Figure 7-42. Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 1 of 2)

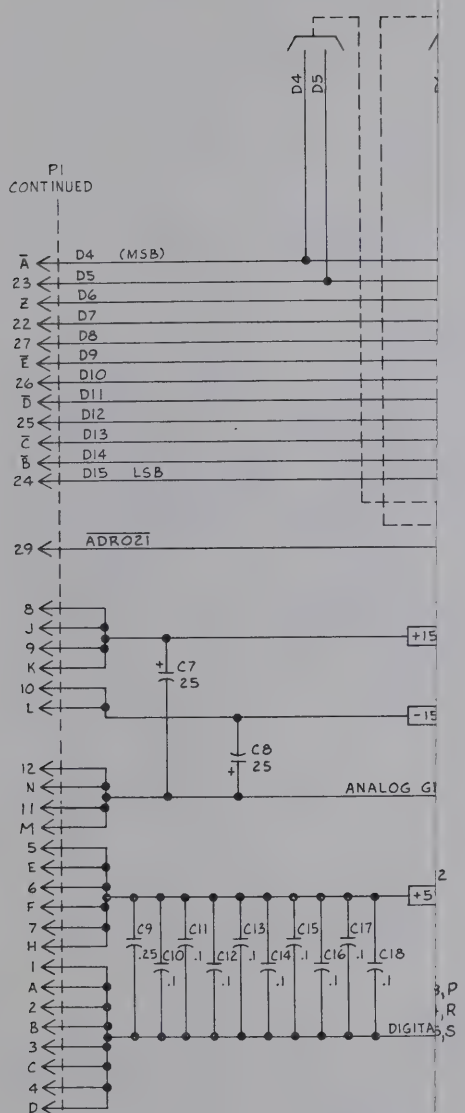
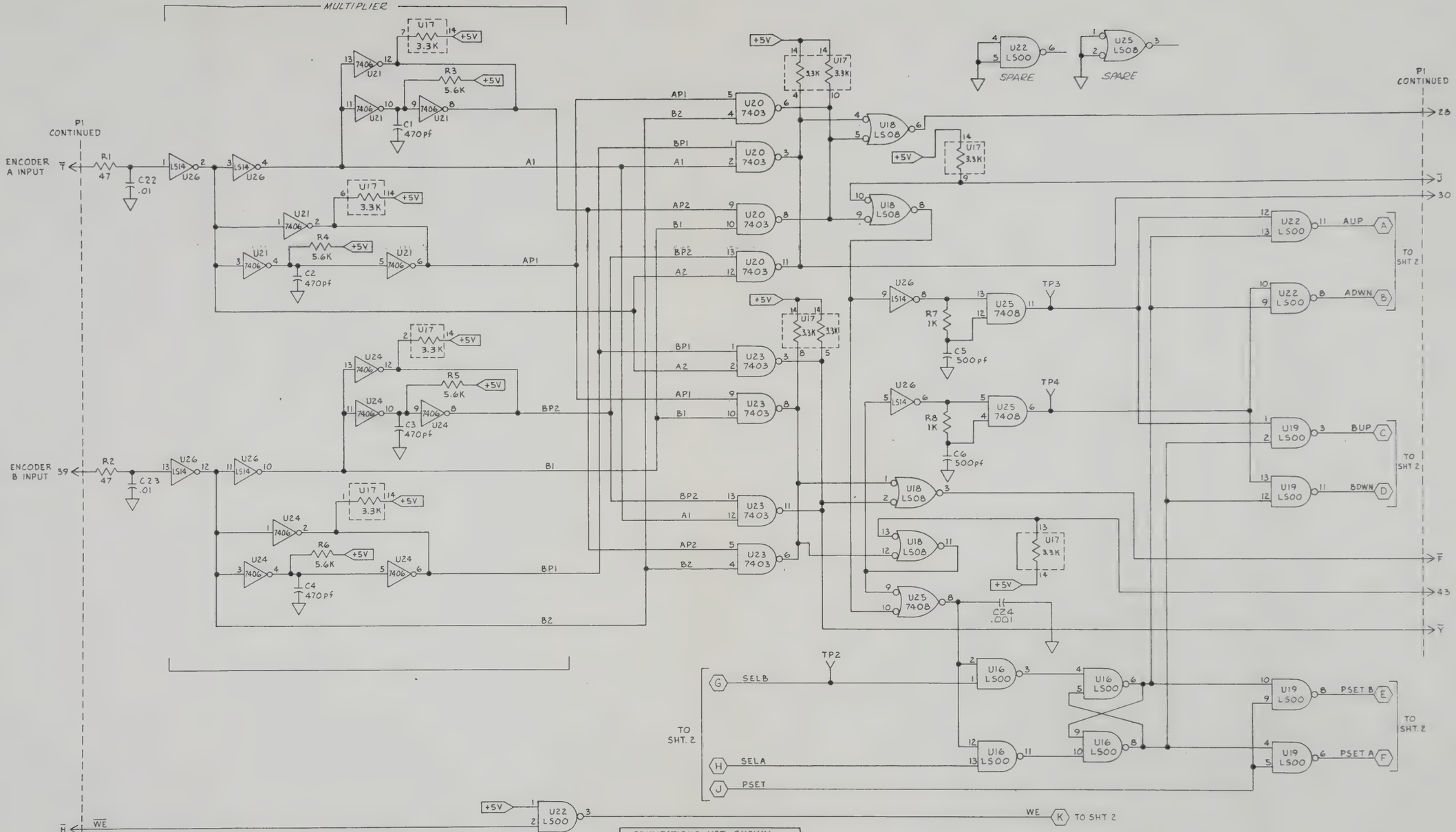


Figure 7-42. Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 2 of 2)



CONNECTIONS NOT SHOWN			
SYM	TYPE	GND	+5V
U16	74LS00	7	14
U18	74LS08	7	14
U19	74LS00	7	14
U20	7403	7	14
U21	7406	7	14
U22	74LS00	7	14
U23	7403	7	14
U24	7406	7	14
U25	7408	7	14
U26	74LS14	7	14

NOTE:
1. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS

Figure 7-42. Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 1 of 2)

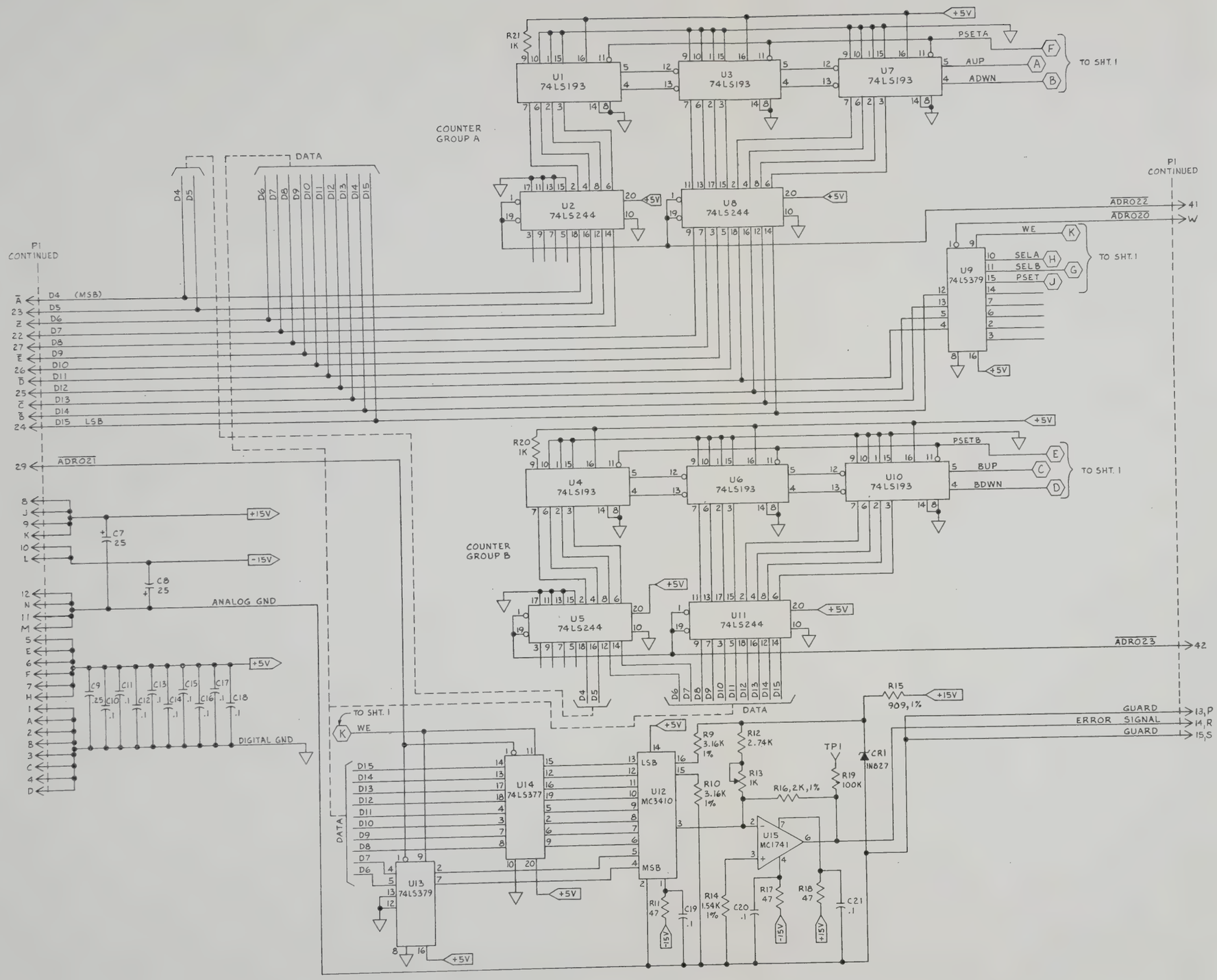


Figure 7-42. Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 2 of 2)

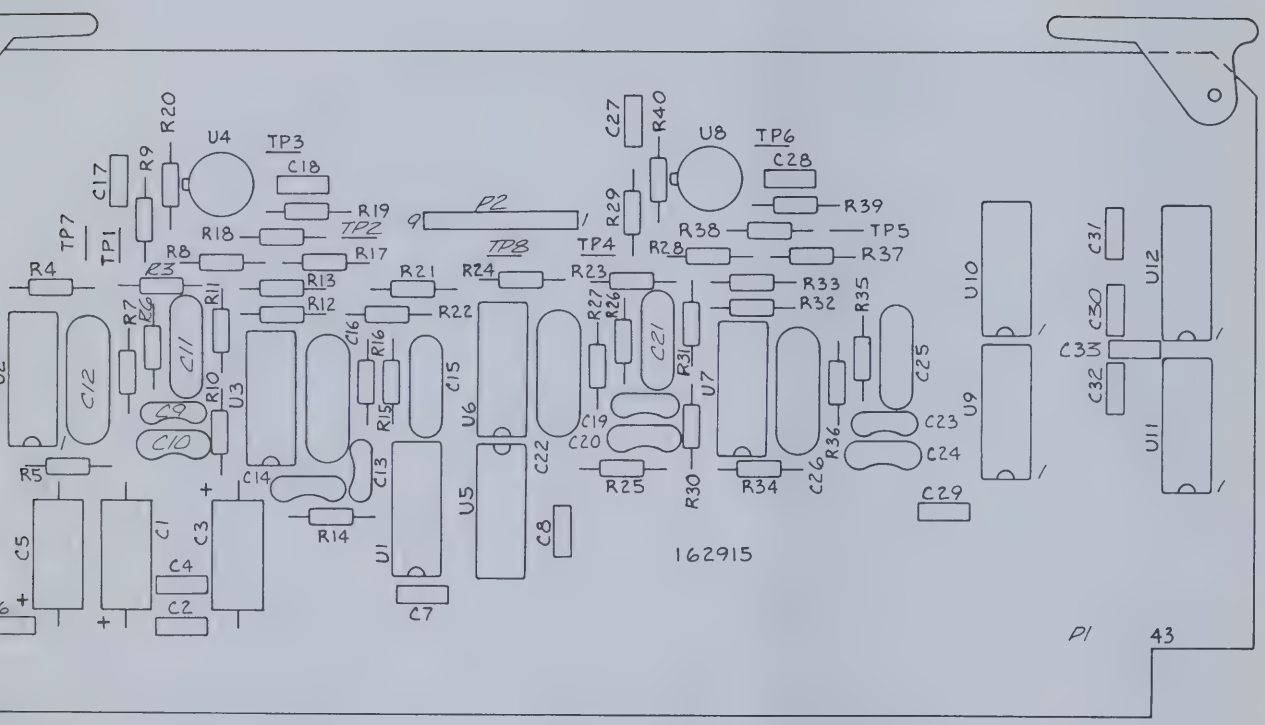


Figure 7-43. Servo Rate Loop Printed Circuit Board (A3A11), Component Location

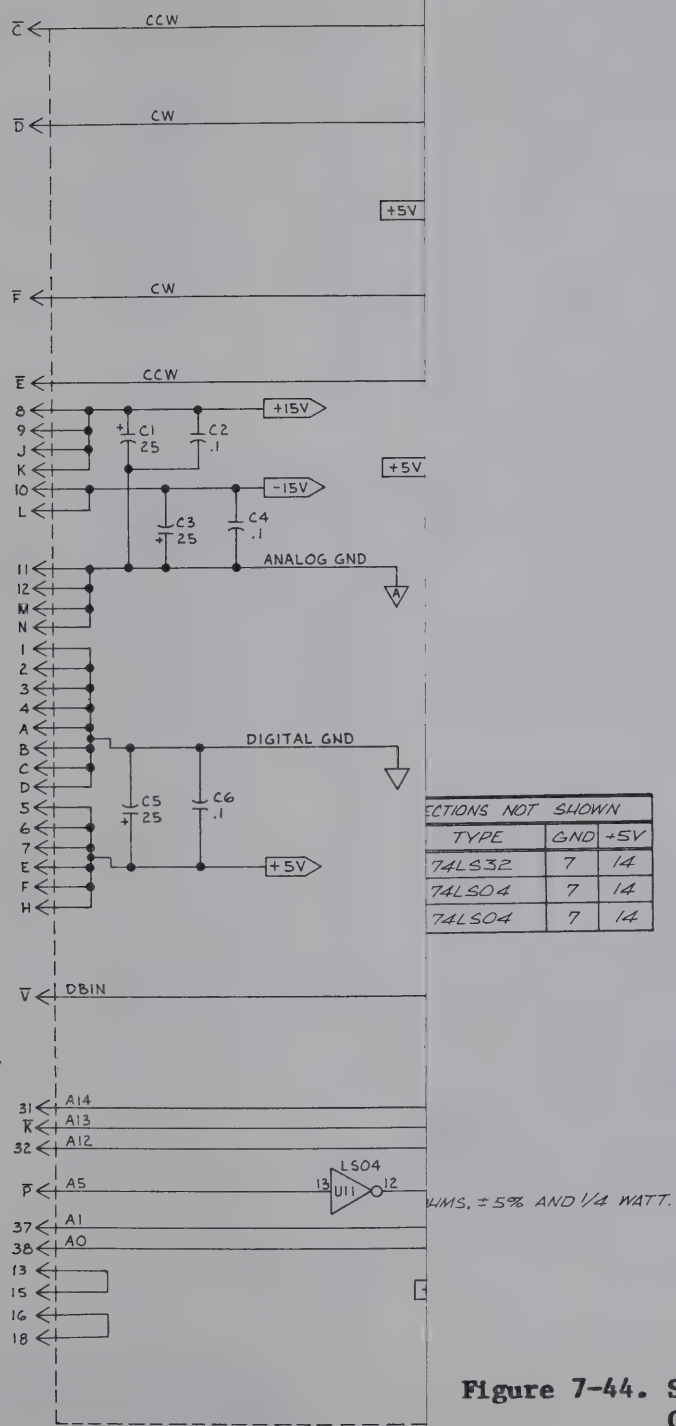


Figure 7-44. Servo Rate Loop Printed Circuit Board (A3A11), Schematic

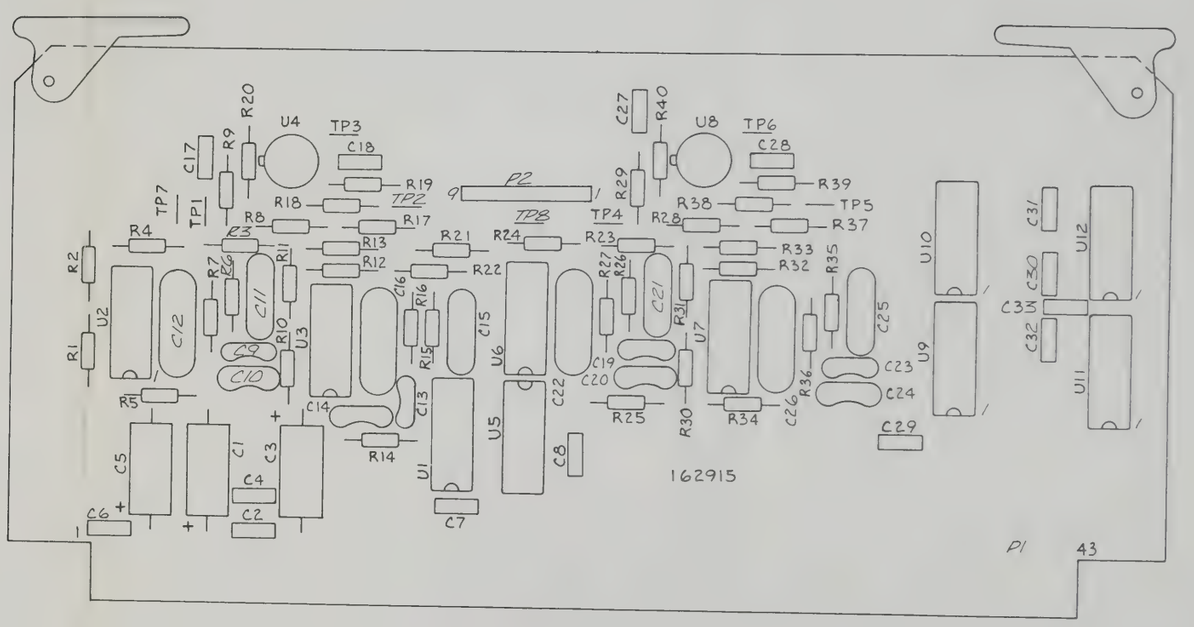
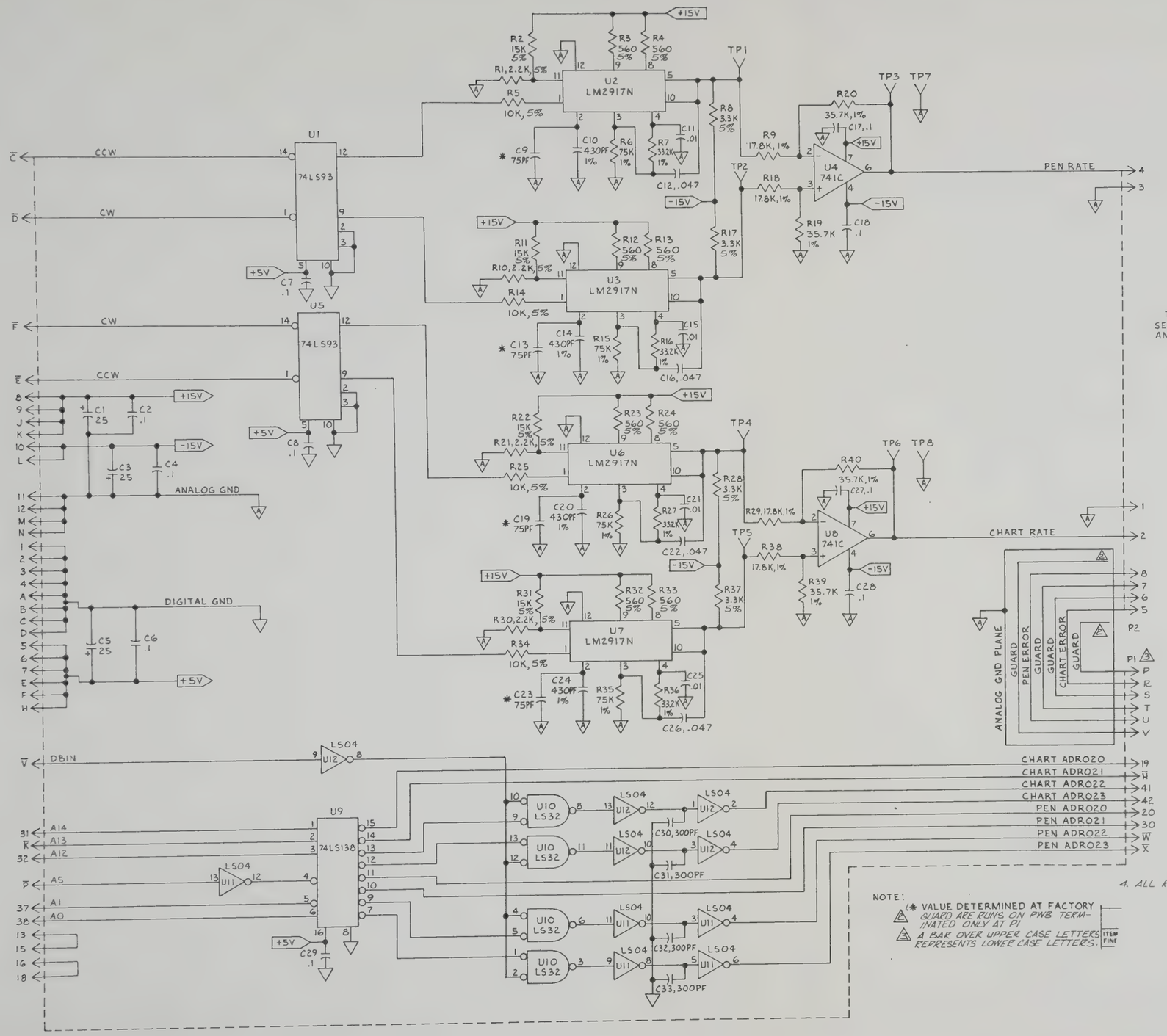


Figure 7-43. Servo Rate Loop Printed Circuit Board (A3A11), Component Location



CONNECTIONS NOT SHOWN			
SYM	TYPE	GND	+5V
U10	74LS32	7	14
U11	74LS04	7	14
U12	74LS04	7	14

NOTE:
1. (* VALUE DETERMINED AT FACTORY
2. GUARD ARE RUNS ON PWB TERMINATED ONLY AT P1
3. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
4. ALL RESISTORS ARE IN OHMS, ±5% AND 1/4 WATT.

Figure 7-44. Servo Rate Loop Printed Circuit Board (A3A11), Schematic

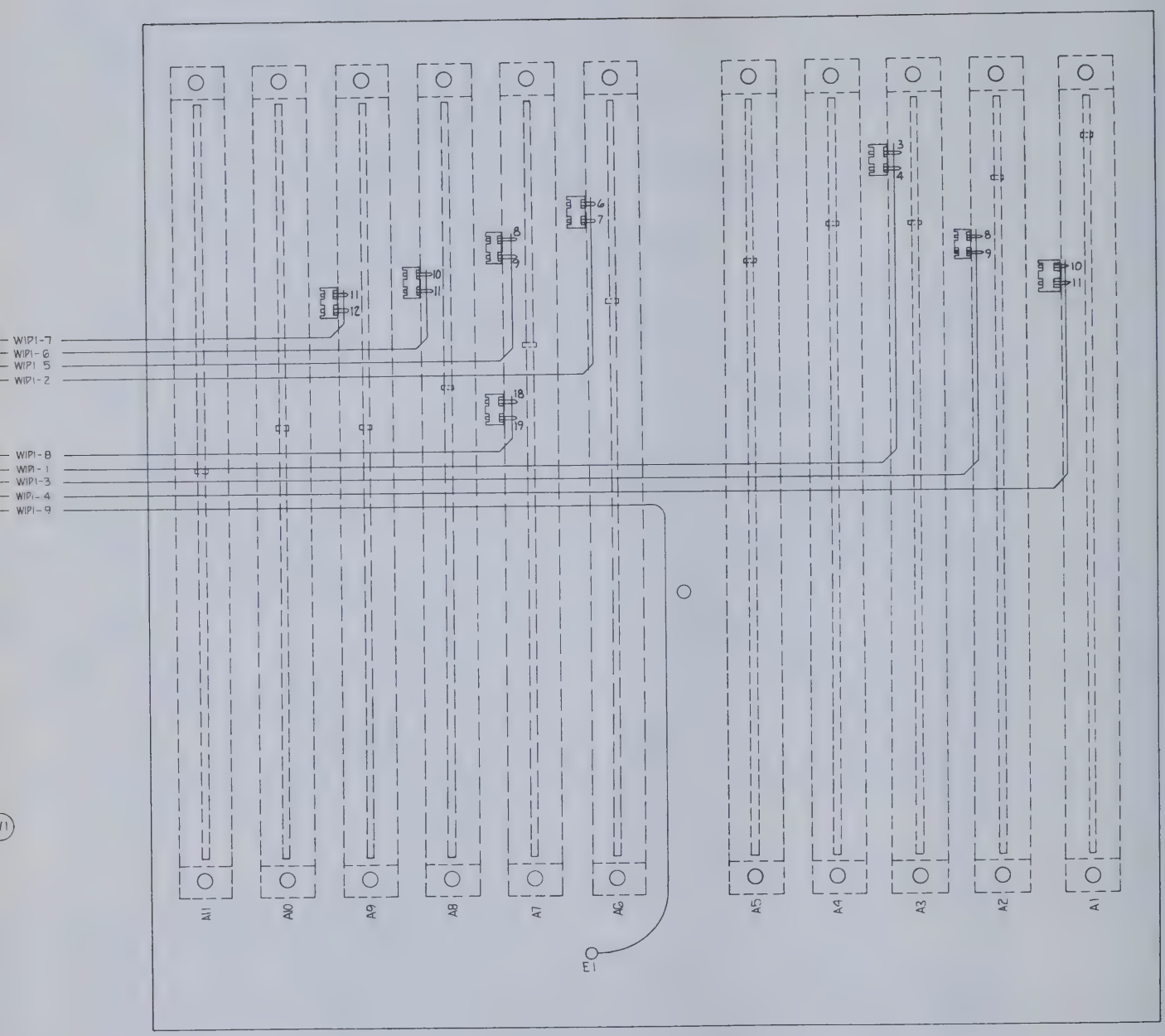


Figure 7-45. Motherboard Printed Circuit Board (A3A12), Component Location

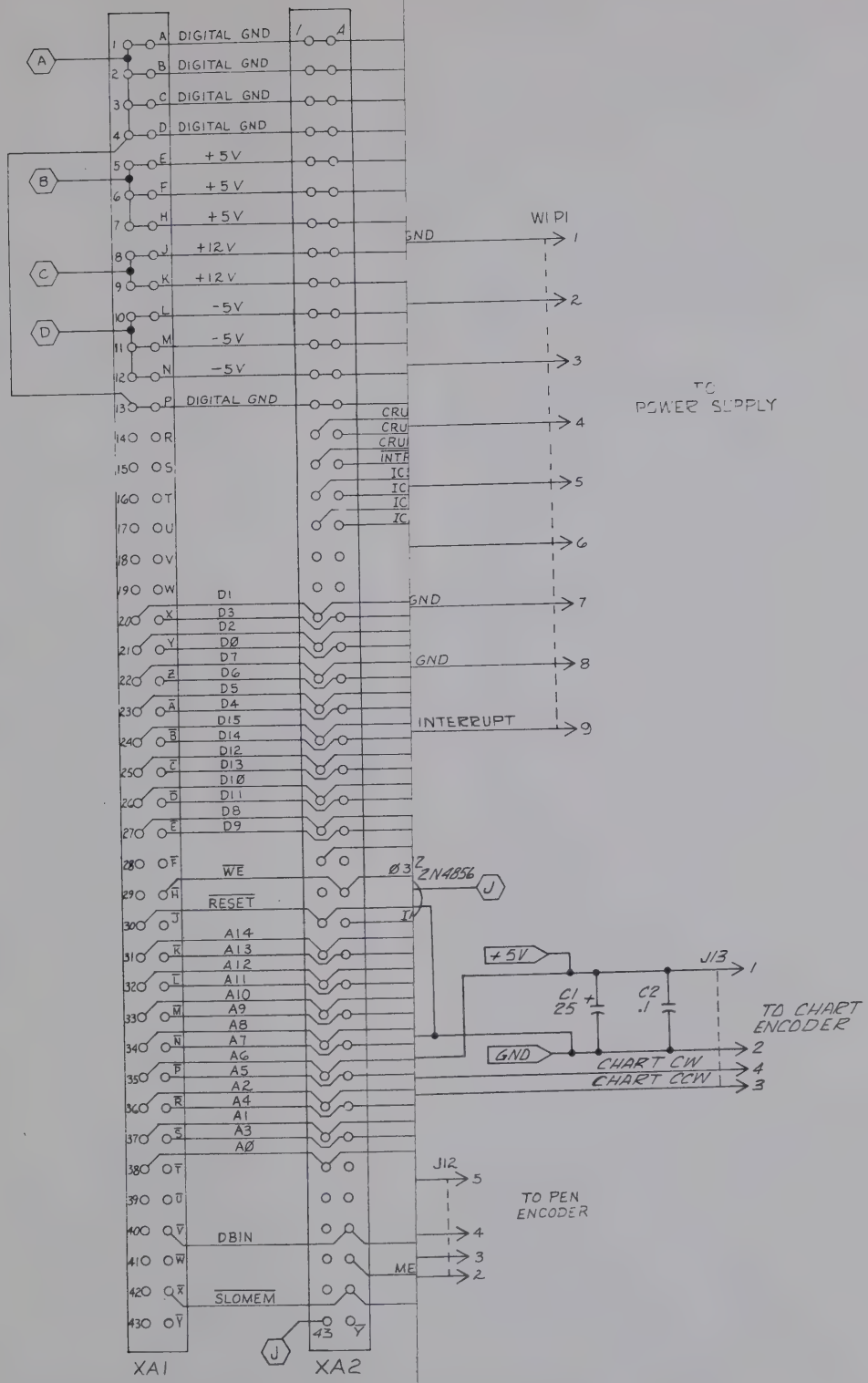
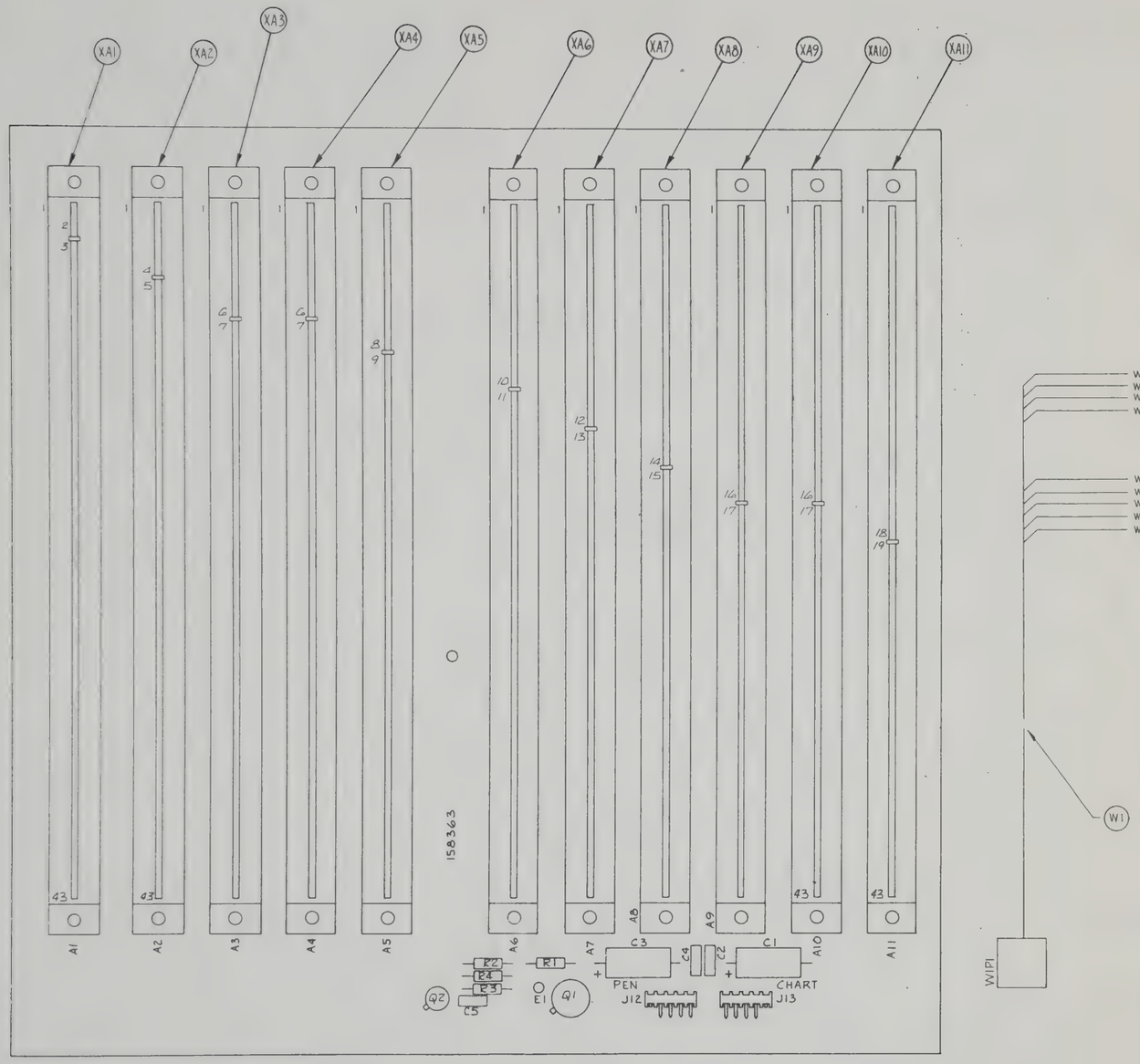


Figure 7-46. Motherboard Printed Circuit Board (A3A12), Schematic

NOTE:
1. LOWER CASE L
REPRESENTED



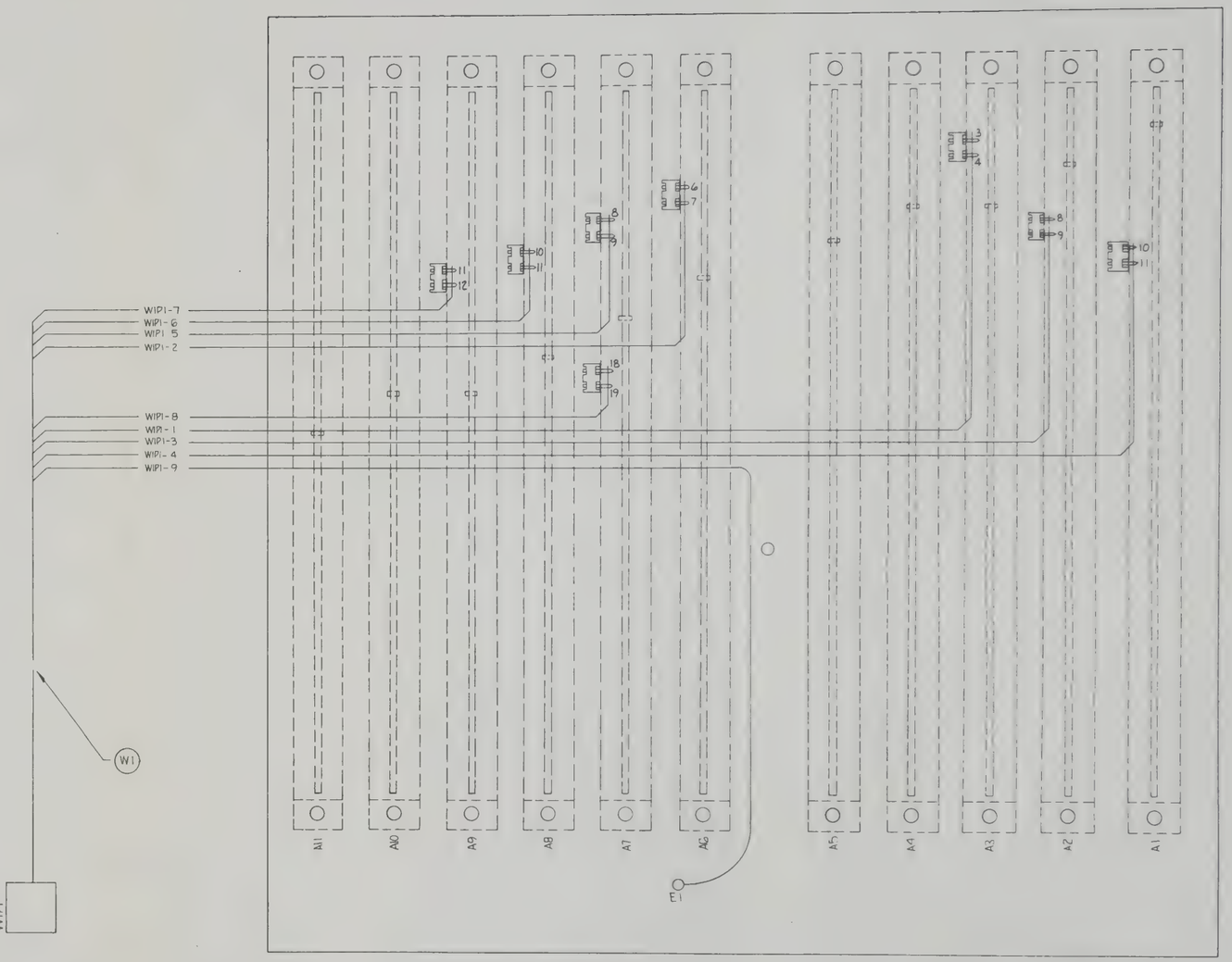


Figure 7-45. Motherboard Printed Circuit Board (A3A12), Component Location

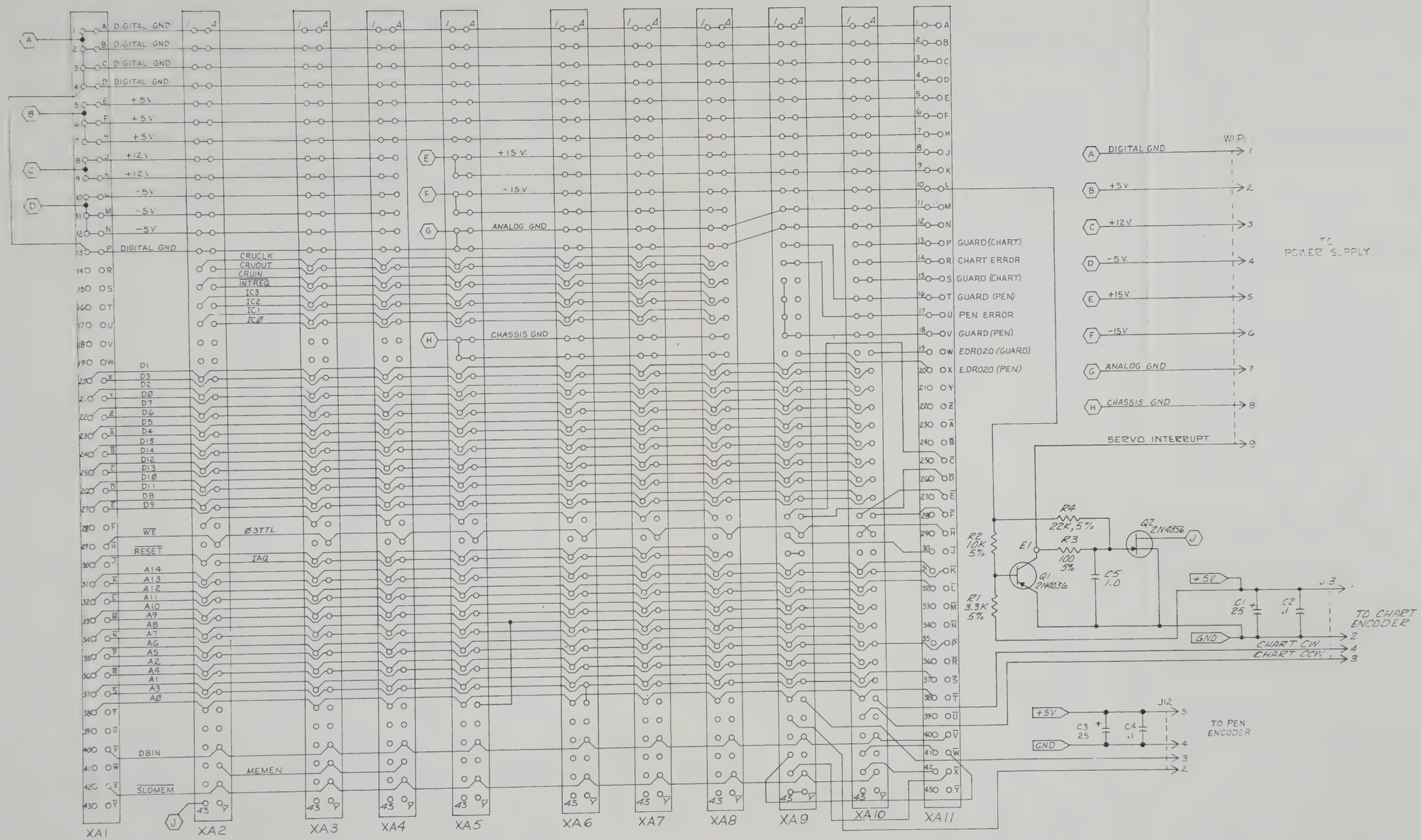


Figure 7-46. Motherboard Printed Circuit Board (A3A12), Schematic

NOTE:
1. LOWER CASE LETTERS ON CONNECTORS ARE REPRESENTED BY A BAR OVER UPPER CASE LETTERS.

SERIES 1580 PATTERN RECORDER, ASSEMBLIES A5, A5A1, A6, AND CABLES

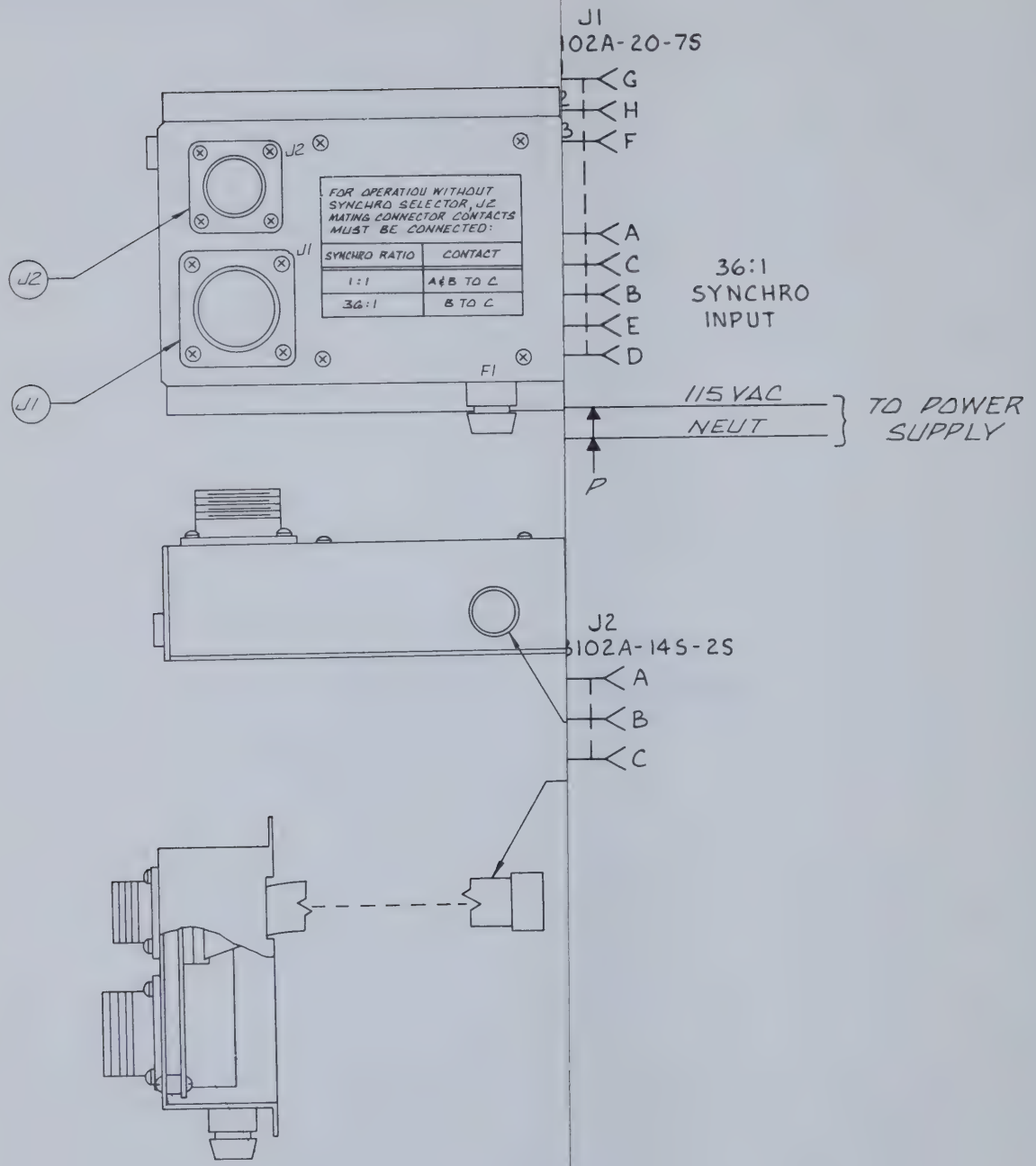


Figure 7-47. Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Component Location

Figure 7-48. Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Schematic

163072A

163048A

41R038E

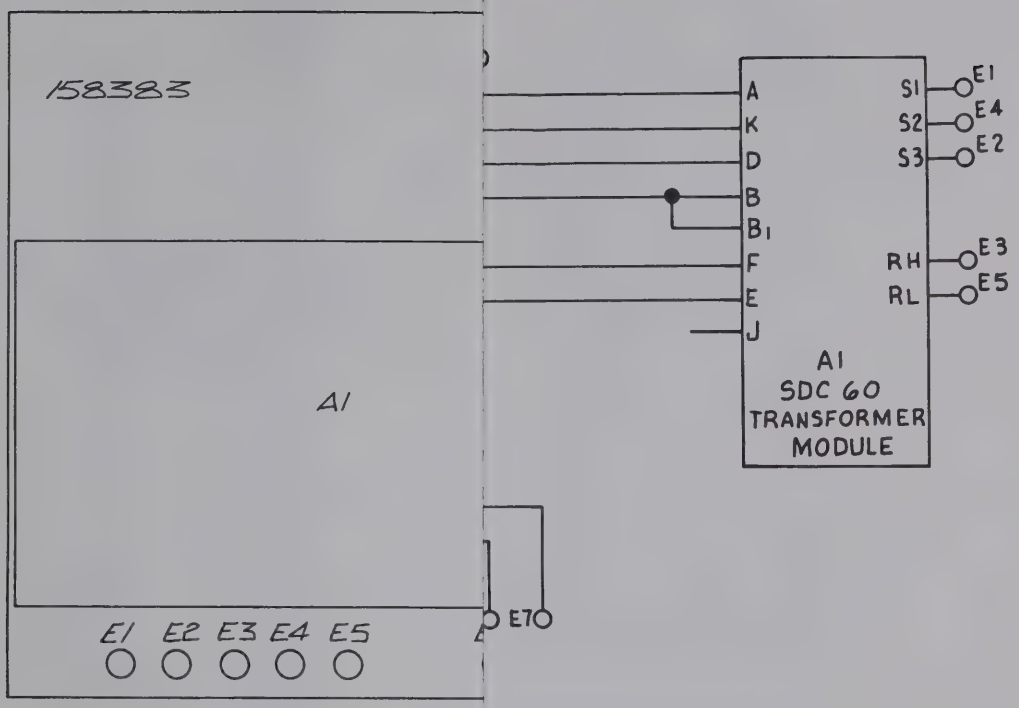


Figure 7-49. Optional Synchro-to-
(S/D) Transformer As
Printed Circuit Boar
Component Location

Figure 7-50. Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Schematic

158383A

158381

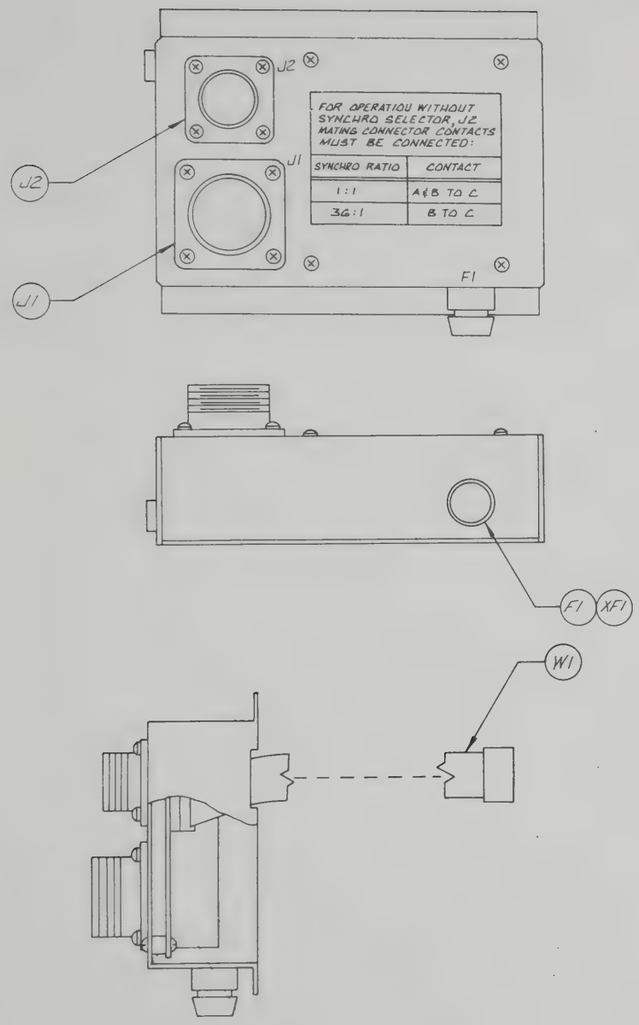


Figure 7-47. Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Component Location

163072A

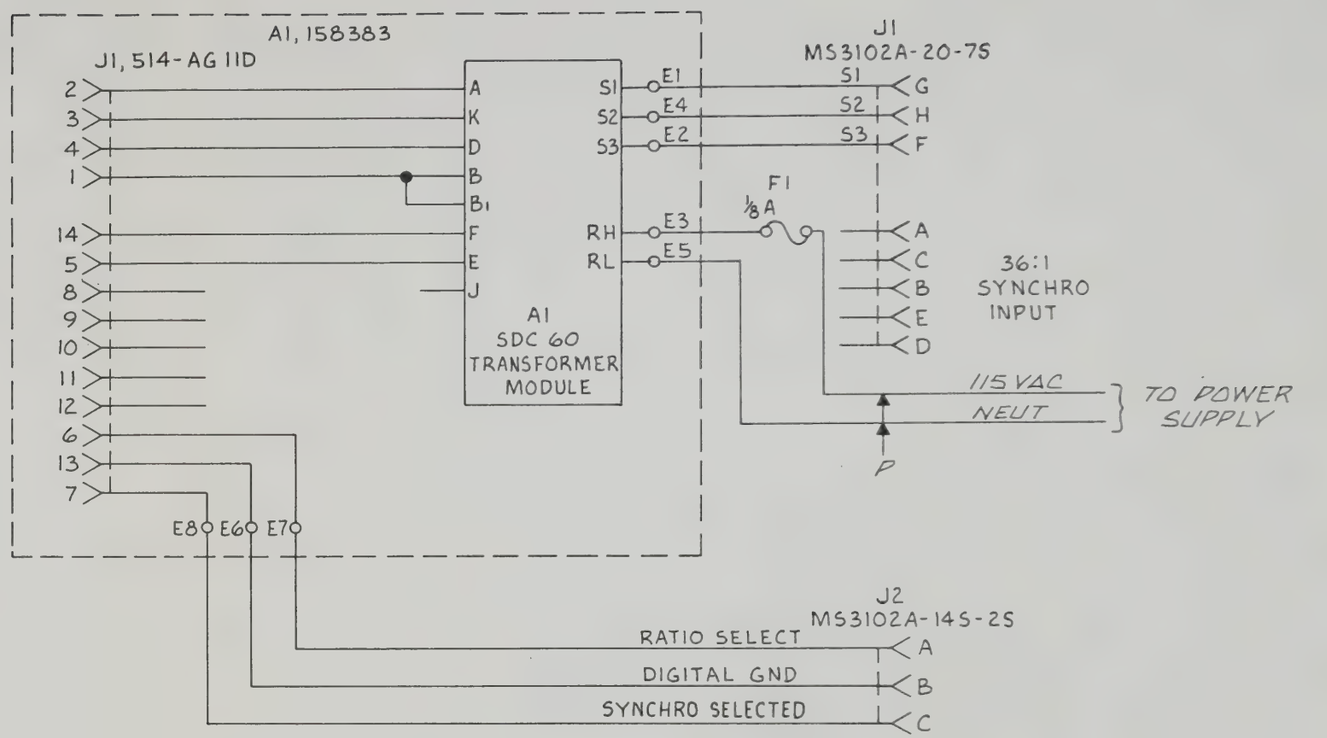


Figure 7-48. Optional Synchro-to-Digital (S/D) Transformer Assembly (A5), Schematic

163048A

41R038E

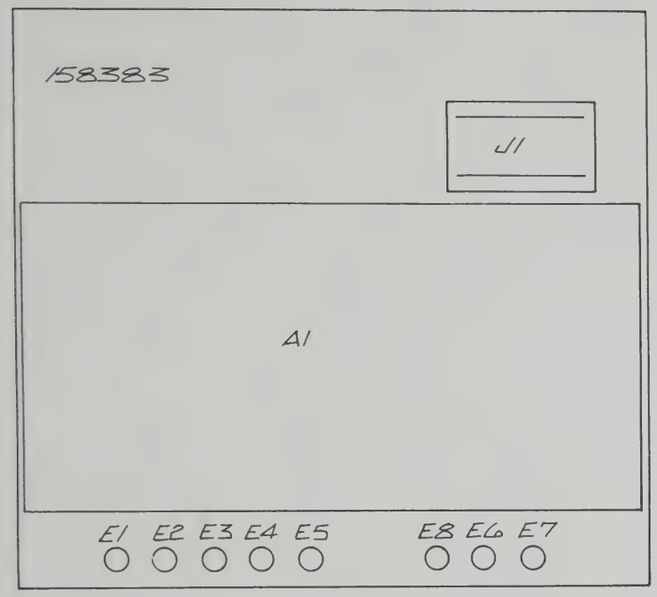


Figure 7-49. Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Component Location

158383A

41R038E

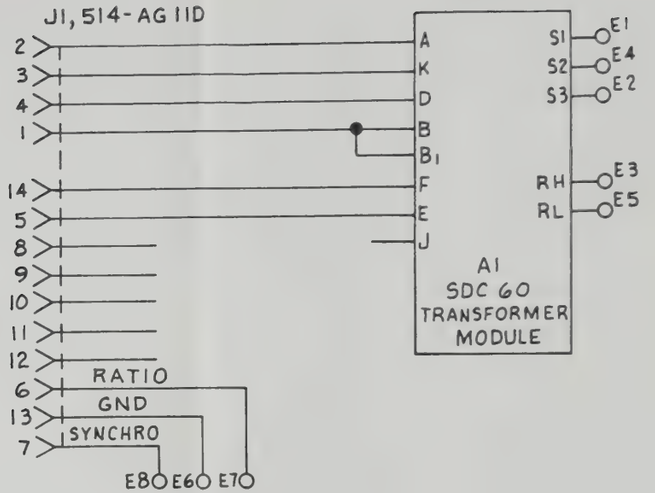
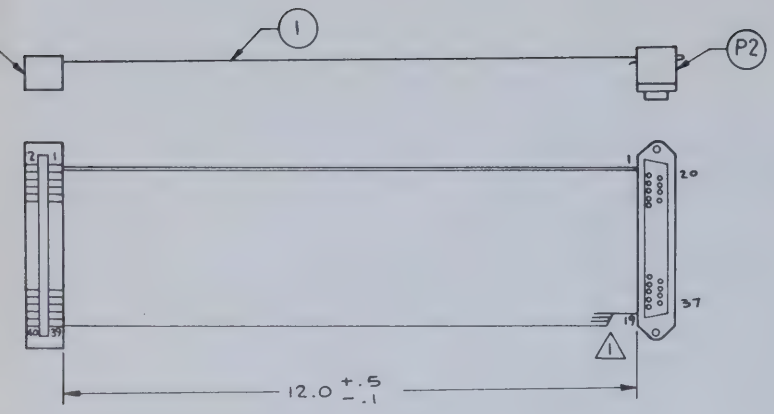
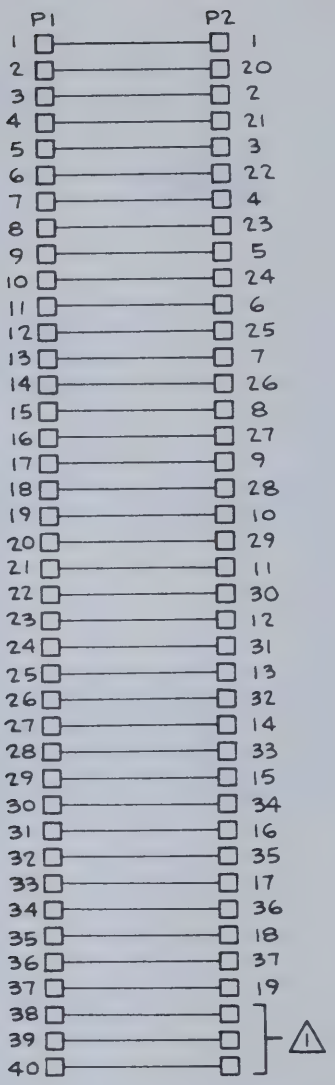


Figure 7-50. Optional Synchro-to-Digital (S/D) Transformer Assembly Printed Circuit Board (A5A1), Schematic

158381





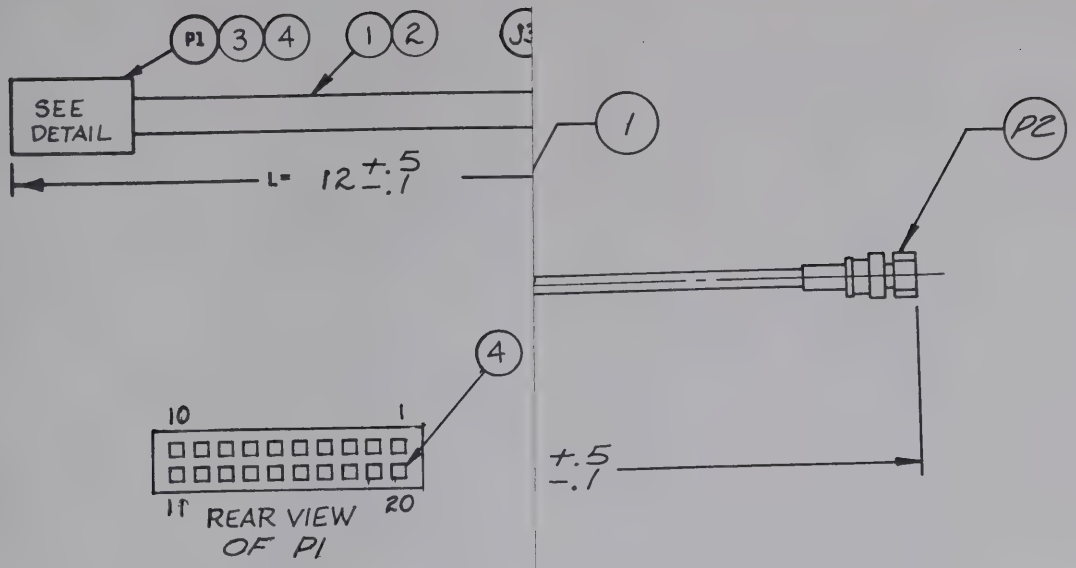
NOTES:

1. TRIM THE 3 UNUSED CONDUCTORS OFF AT CONNECTOR P2

ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG OR S-A PART NO	IDENTIFICATION
P1	Connector	86883	609-4015M
P2	Connector	87172	609-37S
1	Cable, Flat	84304	171-40

Figure 7-52. Optional Digital Interface Panel (A6), Pin-Out Identification for Cables A6W1 and A6W2

164820C



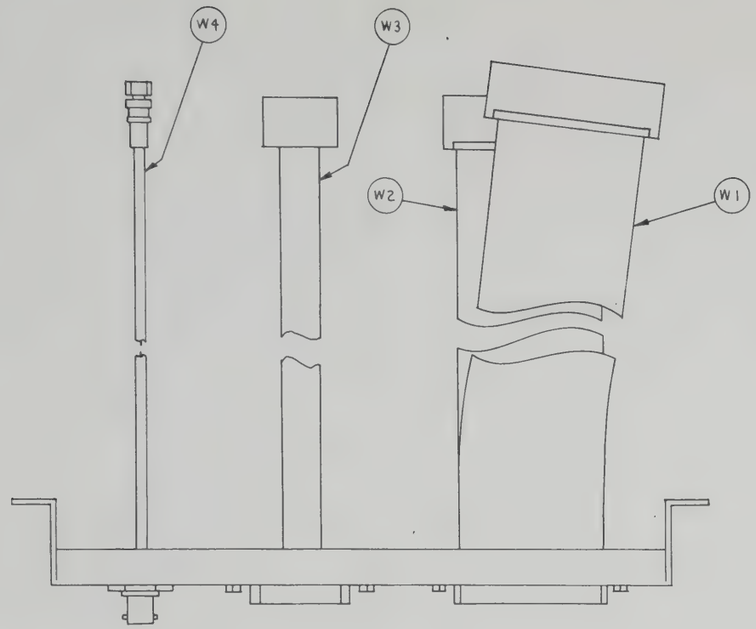
ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG OR A PART NO	IDENTIFICATION
J3	Connector 24 Contacts	84353	BNC
P1	Conn. Housing 20 Positions	83636	Screw-on Male TC
		77400	50 ohm Min .110 OD
1	Wire 24 AWG. Strd.		
2	Tubing, Black PVC 105, 3/8 dia.		
3	Contact Conn. AWG 22-26		
4	Plug, Keying		

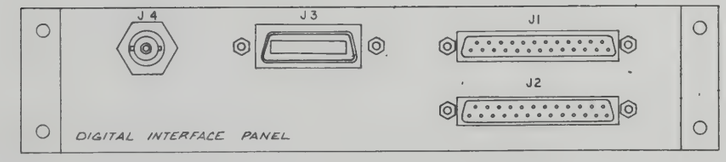
Figure 7-53. Optional Digital Inte Panel (A6), Pin-Out Identification for Ca

164857

Figure 7-54. Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W4

164858



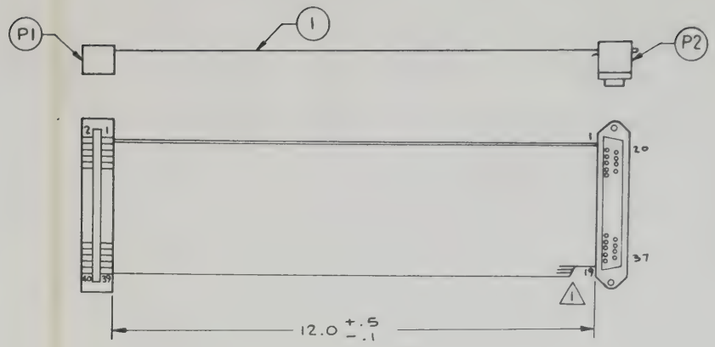


NOTE:
1. J1, J2, J3 & J4 FOR REFERENCE ONLY.

Figure 7-51. Optional Digital Interface Panel (A6), Assembly Outline and Cable Identification

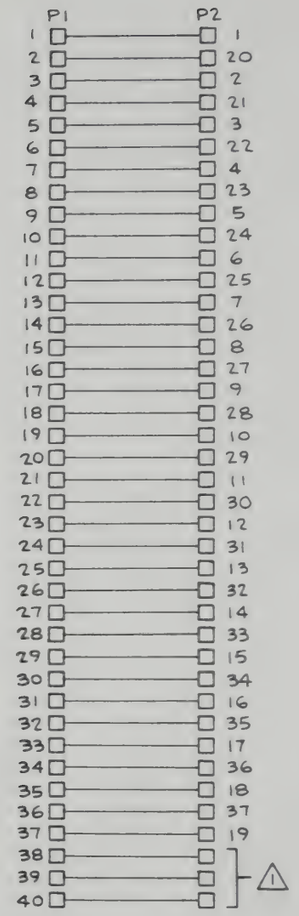
162121A

41R038E



NOTES:

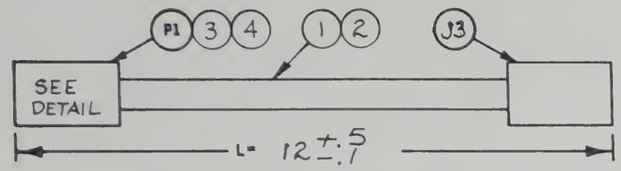
⚠1 TRIM THE 3 UNUSED CONDUCTORS OFF AT CONNECTOR P2

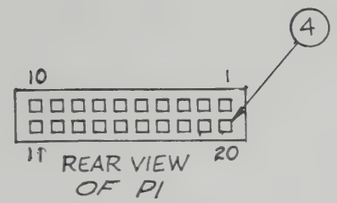


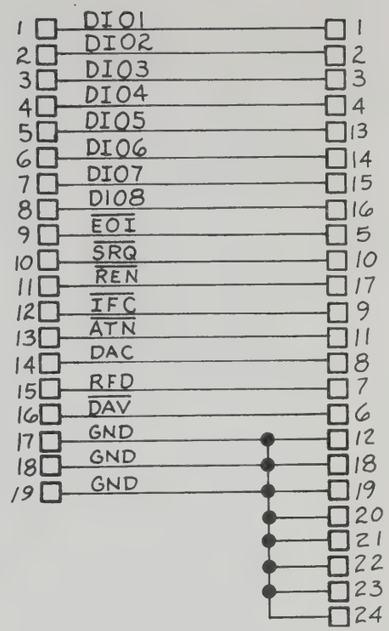
ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG OR S-A PART NO	IDENTIFICATION
P1	Connector	86883	609-4015M
P2	Connector	87172	609-37S
1	Cable, Flat	84304	171-40

Figure 7-52. Optional Digital Interface Panel (A6), Pin-Out Identification for Cables A6W1 and A6W2

164820C

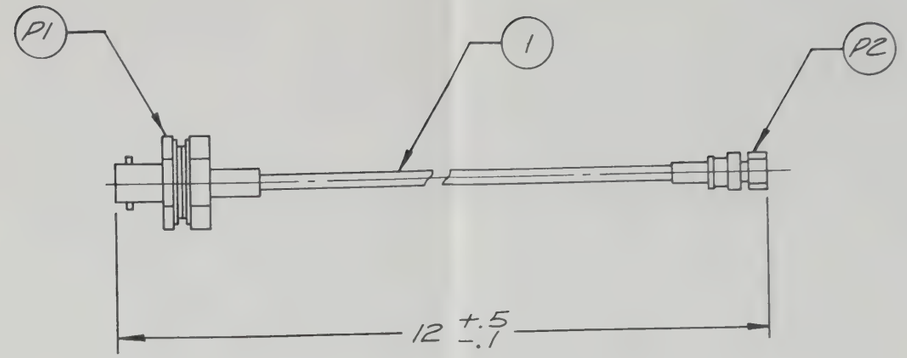






ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG OR S-A PART NO	IDENTIFICATION
J3	Connector 24 Contacts	78947	57-20240
P1	Conn. Housing 20 Positions	82954	87133-6
1	Wire 24 AWG. Strd.	73415	
2	Tubing, Black PVC 105, 3/8 dia.	73232	
3	Contact Conn. AWG 22-26	82955	87165-1
4	Plug, Keying	83300	86286-1

Figure 7-53. Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W3



ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG OR S-A PART NO	IDENTIFICATION
P1	Connector, Coax	84353	BNC
P2	Connector, Coax	83636	Screw-on Male TC
1	Cable, Coax	77400	50 ohm Min .110 OD

Figure 7-54. Optional Digital Interface Panel (A6), Pin-Out Identification for Cable A6W4

CHAPTER 8
SUPPLEMENTAL INFORMATION

8.0 GENERAL

8.1 Several original component location and schematic drawings are provided in this chapter in order to support earlier manufactured 1580 Pattern Recorders (Units with Serial Numbers around 16 and below). Only these early assemblies that have since been modified from their original configuration are included as listed in the Index below.

INDEX

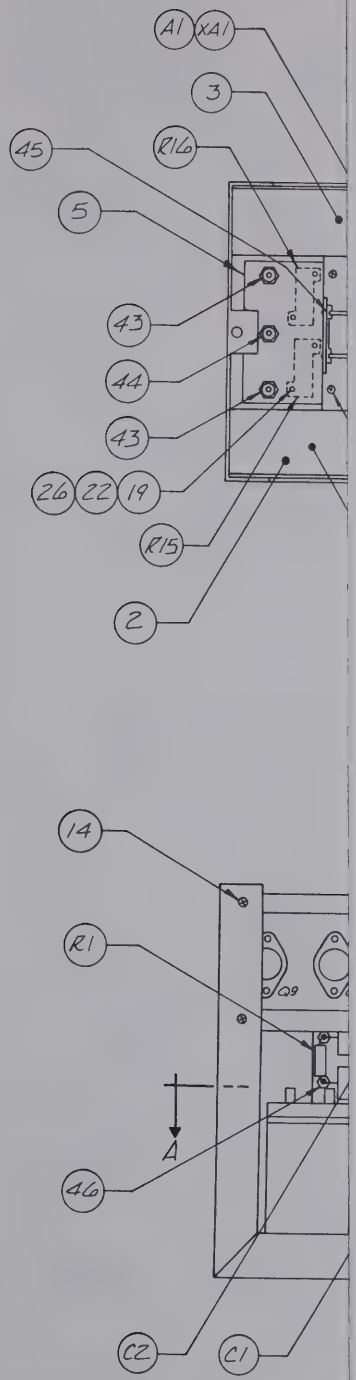
Figure	Title	Page
8.1-1	Power Supply Assembly (A2), Component Location (Sheet 1 of 2)	8-5
8.1-1	Power Supply Assembly (A2), Component Location (Sheet 2 of 2)	8-6
8.1-2	Power Supply Assembly (A2), System Servo Amplifier Printed Circuit Board (A2A2), Component Location	8-7
8.1-3	Power Supply Assembly (A2), System Servo Amplifier Printed Circuit Board (A2A2), Schematic Diagram	8-8

INDEX - continued

Figure	Title	Page
8.1-4	Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic Diagram (Sheet 1 of 3)	8-9
8.1-4	Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic Diagram (Sheet 2 of 3)	8-10
8.1-4	Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic Diagram (Sheet 3 of 3)	8-11
8.1-5	Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic Diagram (Sheet 1 of 3)	8-12
8.1-5	Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic Diagram (Sheet 2 of 3)	8-13
8.1-5	Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic Diagram (Sheet 3 of 3)	8-14
8.1-6	Data Processing Assembly (A3), Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic Diagram	8-15
8.1-7	Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Component Location	8-16
8.1-8	Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic Diagram (Sheet 1 of 2)	8-17

INDEX - continued

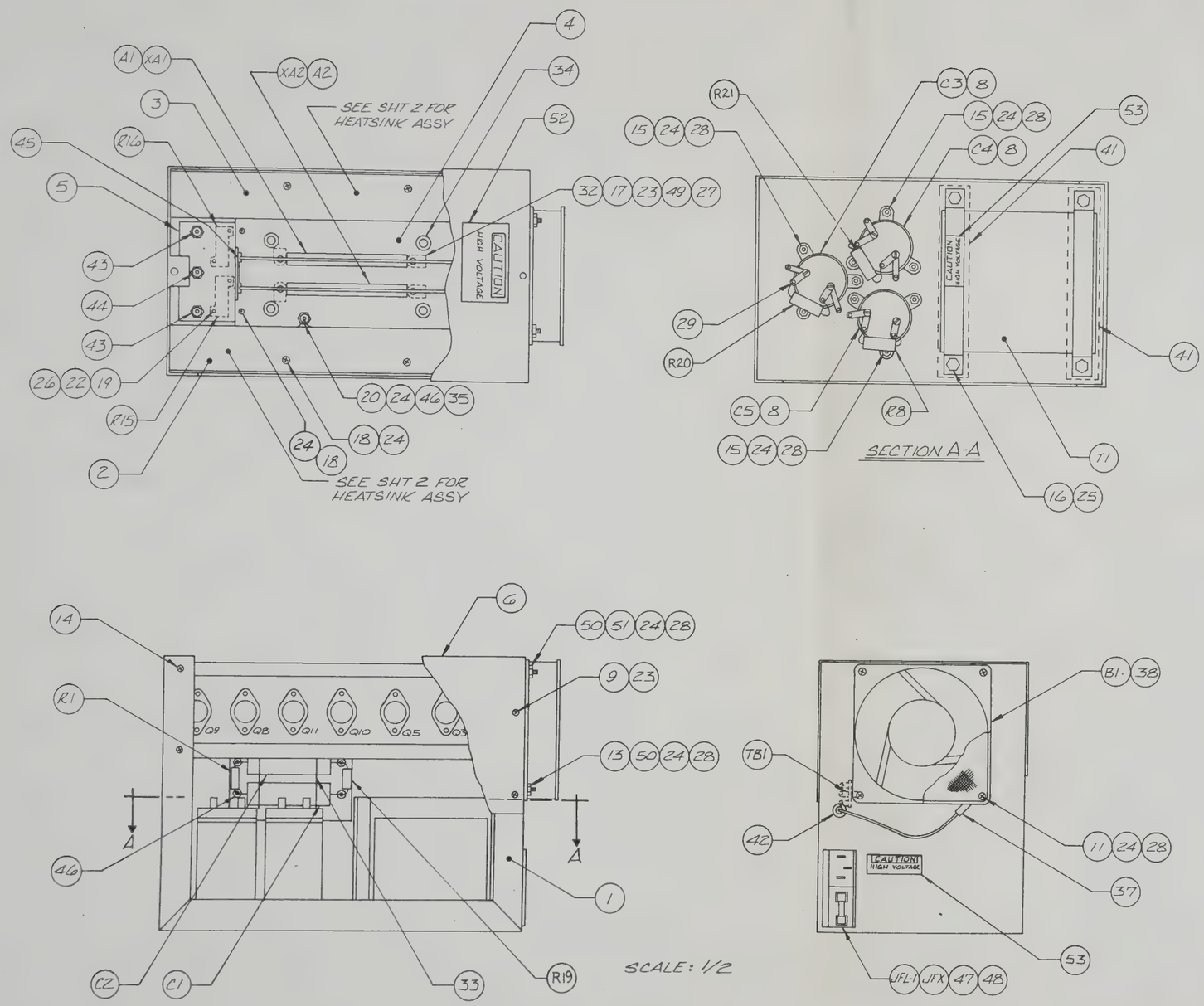
Figure	Title	Page
8.1-8	Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic Diagram (Sheet 2 of 2)	8-18



NOTE:

1. W1, W2, W3 & W4 NOT SHOWN FOR WIRING OF CABLES.
2. ITEM 39 NOT SHOWN.

Figure 8.1-1. Power Supply Assembly (A2), Component Location (Sheet 1 of 2)



NOTE:

1. W1, W2, W3 & W4 NOT SHOWN, SEE WIRING DIAGRAM 163038 FOR WIRING OF CABLES.
2. ITEM 39 NOT SHOWN.

Figure 8.1-1. Power Supply Assembly (A2), Component Location (Sheet 1 of 2)

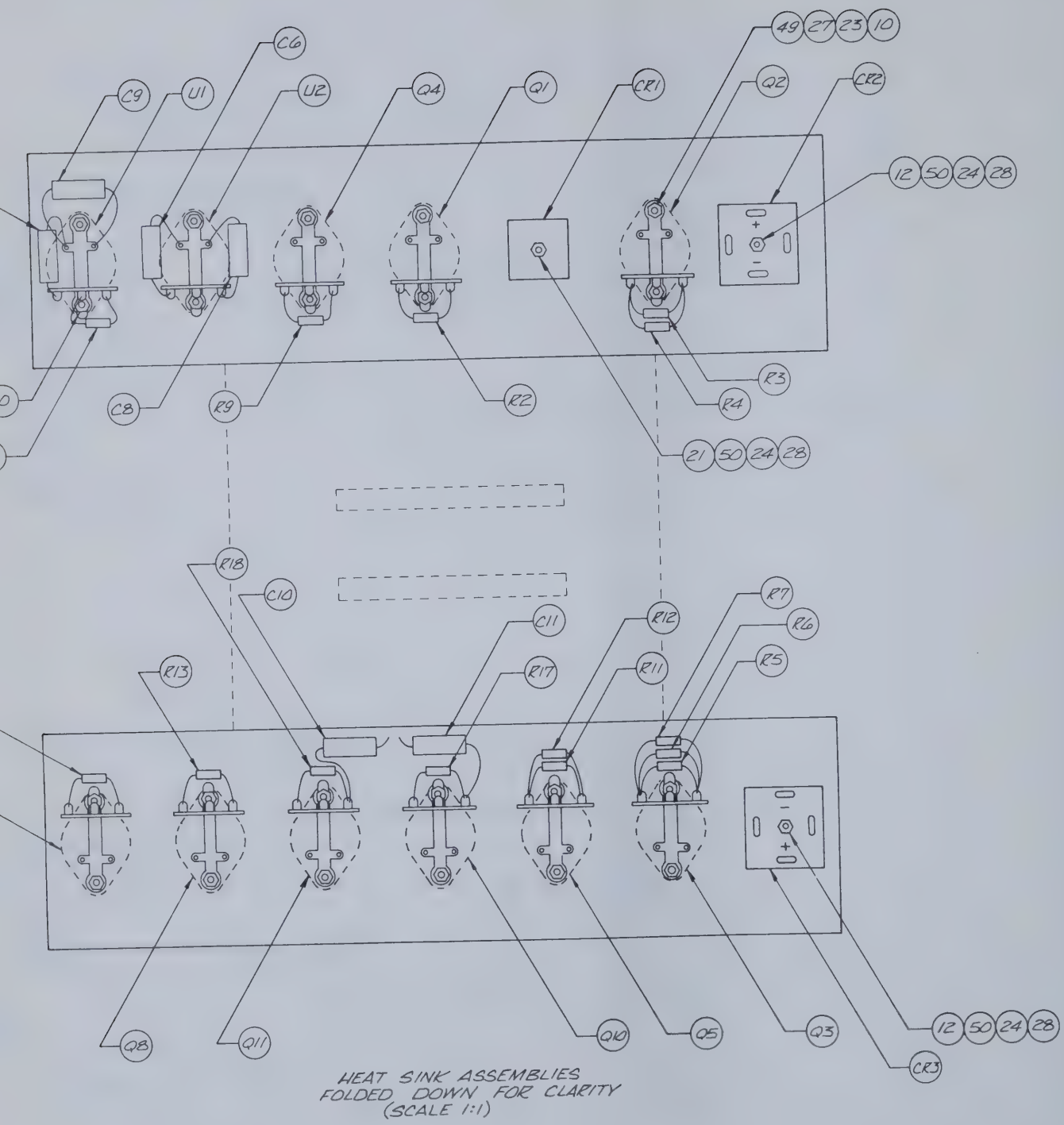


Figure 8.1-1. Power Supply Assembly (A2), Component Location (Sheet 2 of 2)

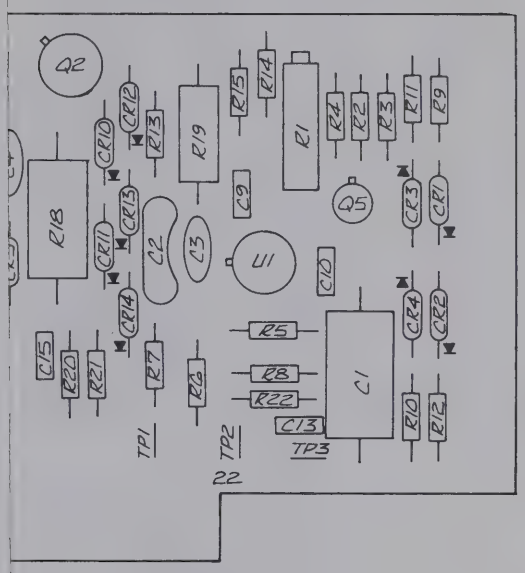


Figure 8.1-2. Power Supply Assembly (A2), System Servo Amplifier Printed Circuit Board (A2A2), Component Location

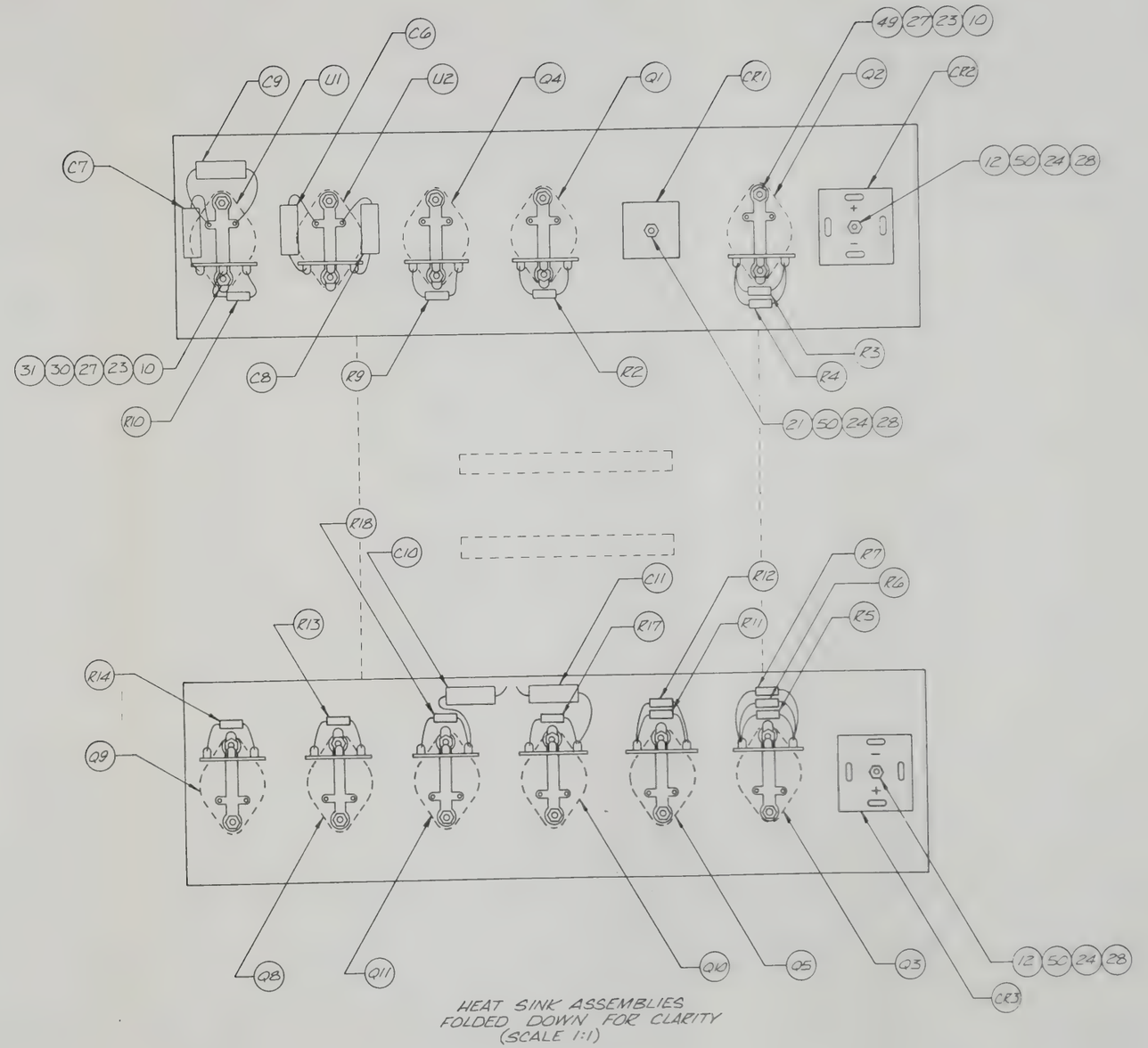
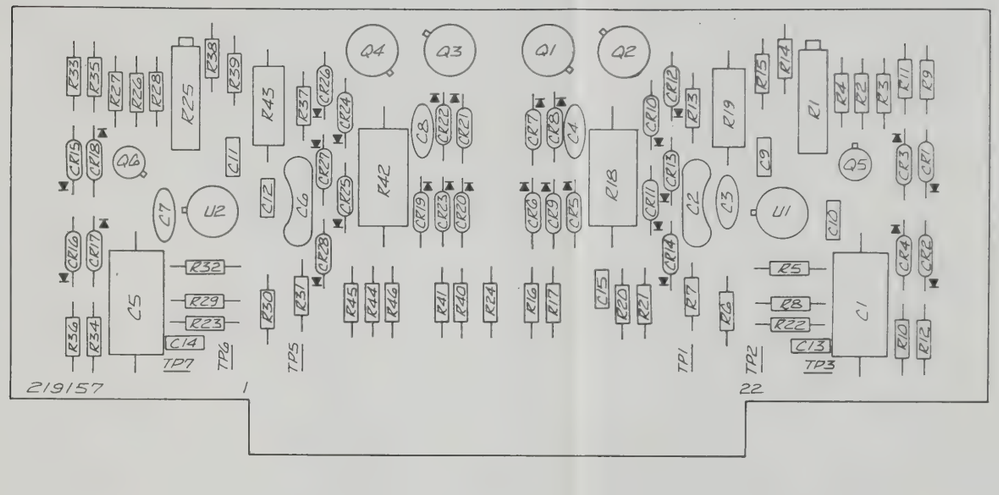


Figure 8.1-1. Power Supply Assembly (A2), Component location (Sheet 2 of 2)



NOTE:
1. THIS DWG. SUPERCEDES 162952 AND APPLIES TO SERIAL NO. 16 THRU ___.
2. REFERENCE SYMBOLS NOT USED: TP4

Figure 8.1-2. Power Supply Assembly (A2), System Servo Amplifier Printed Circuit Board (A2A2), Component Location

Figure 8.1-3. Power Supply Assembly (A2), System Servo Amplifier Printed Circuit Board (A2A2), Schematic

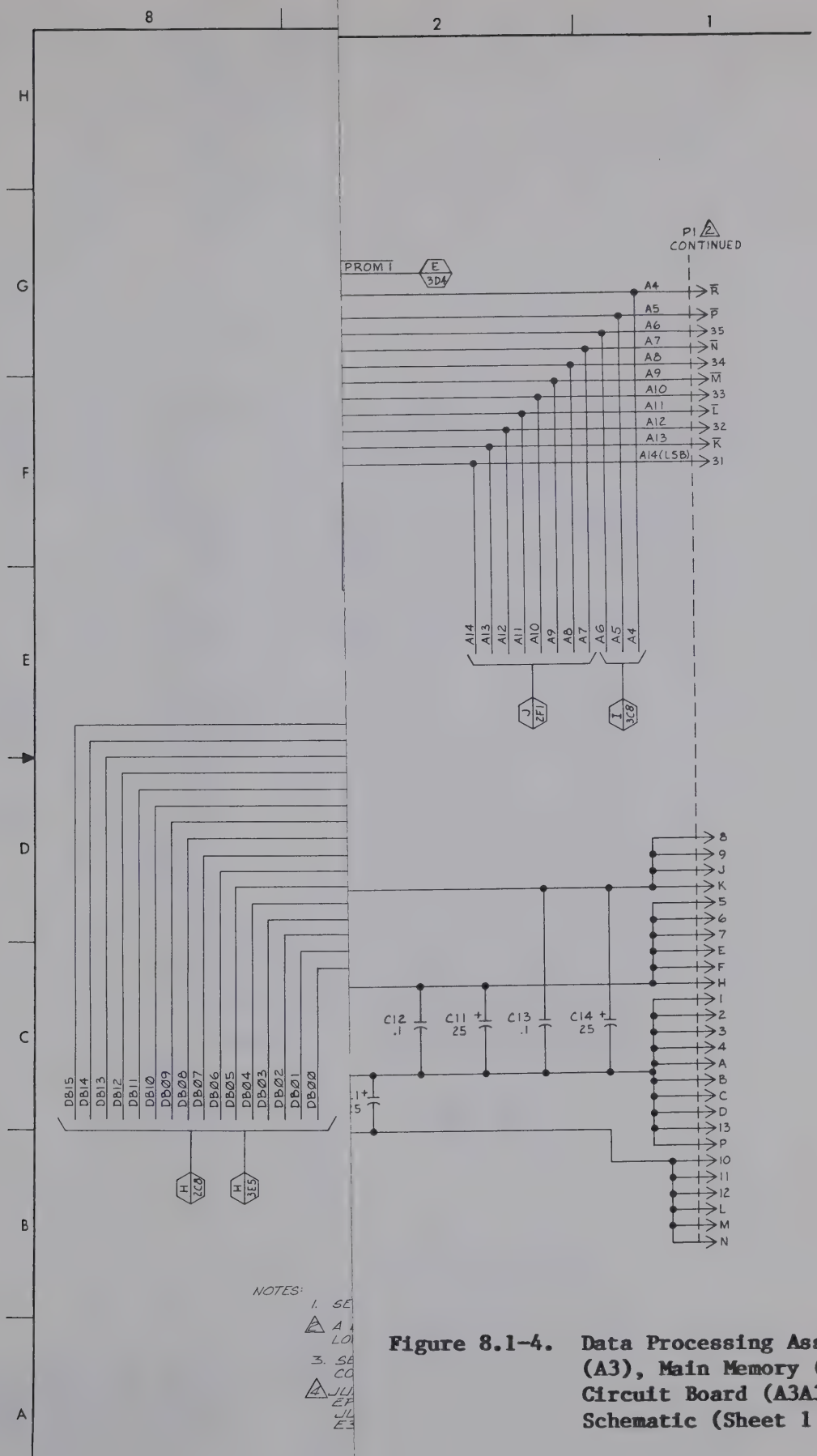


Figure 8.1-4. Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic (Sheet 1 of 3)

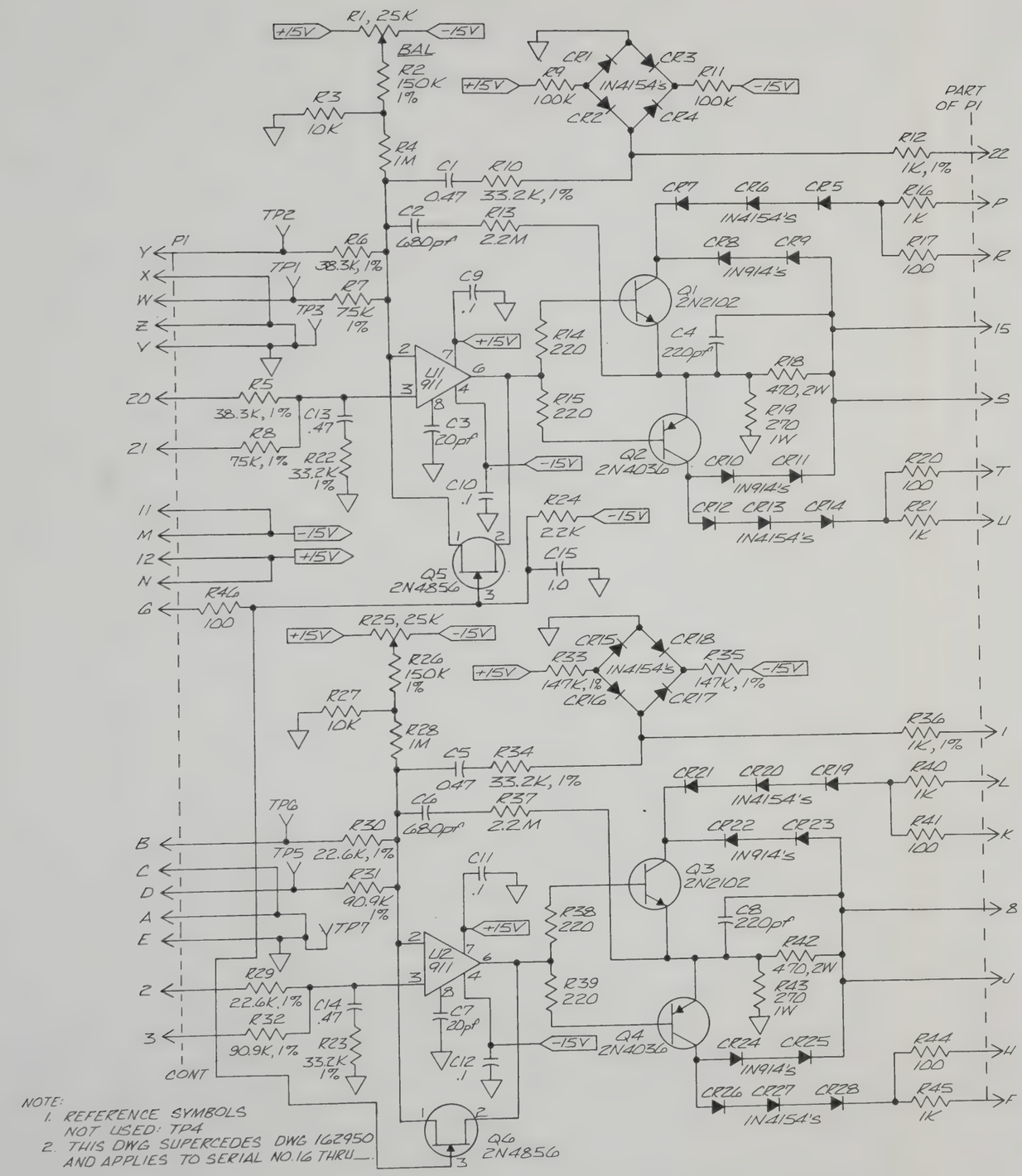
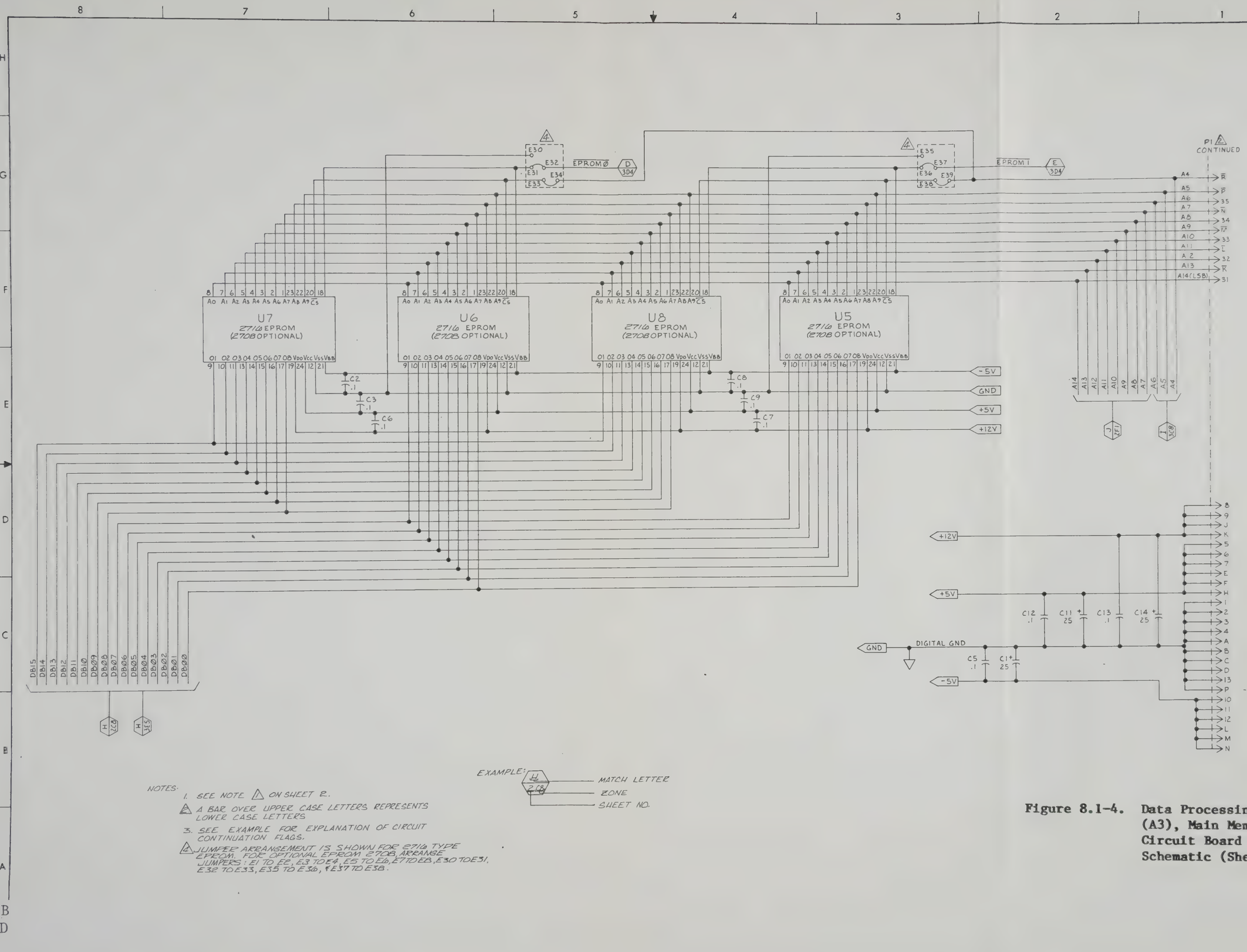


Figure 8.1-3. Power Supply Assembly (A2), System Servo Amplifier Printed Circuit Board (A2A2), Schematic



NOTES:

1. SEE NOTE ⚠1 ON SHEET 2.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS
3. SEE EXAMPLE FOR EXPLANATION OF CIRCUIT CONTINUATION FLAGS.
4. JUMPER ARRANGEMENT IS SHOWN FOR 2716 TYPE EPROM. FOR OPTIONAL EPROM 2708, ARRANGE JUMPERS: E1 TO E2, E3 TO E4, E5 TO E6, E7 TO E8, E30 TO E31, E32 TO E33, E35 TO E36, & E37 TO E38.

EXAMPLE:

Figure 8.1-4. Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic (Sheet 1 of 3)

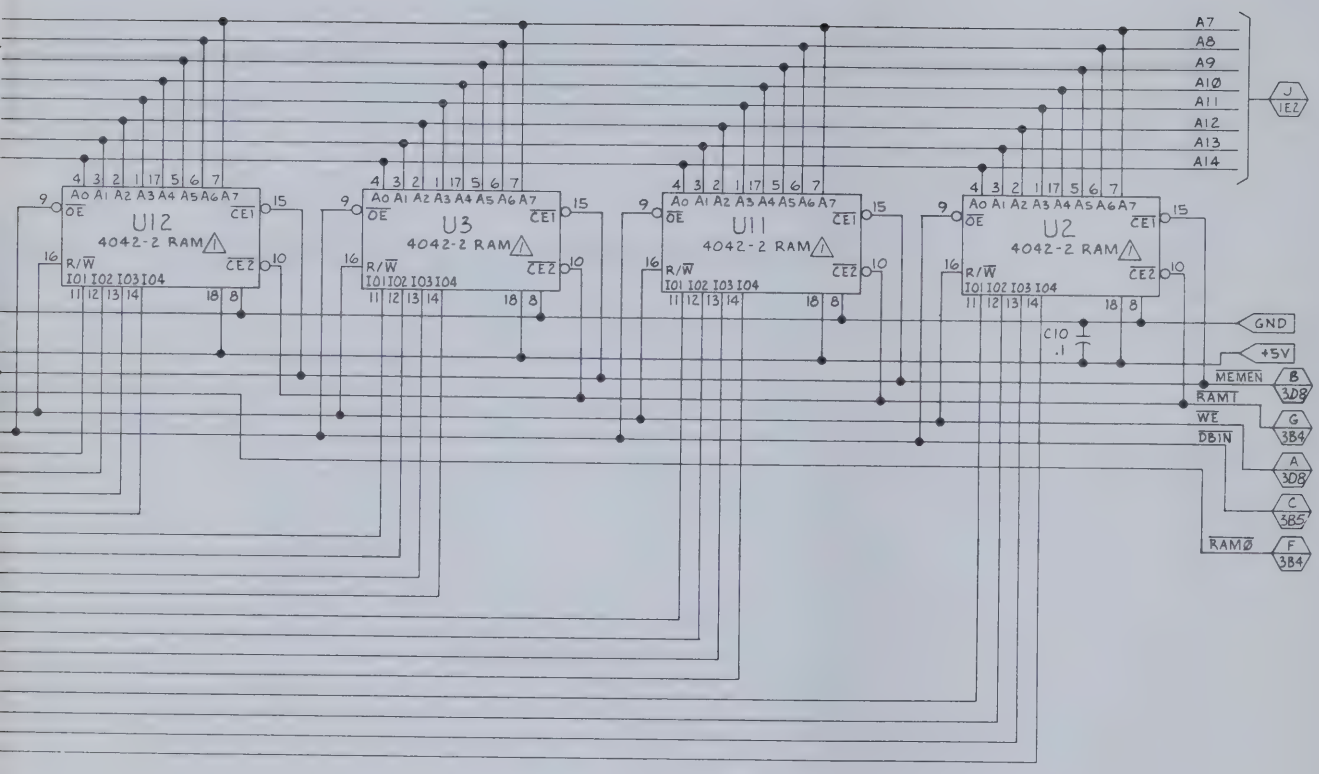


Figure 8.1-4. Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic (Sheet 2 of 3)

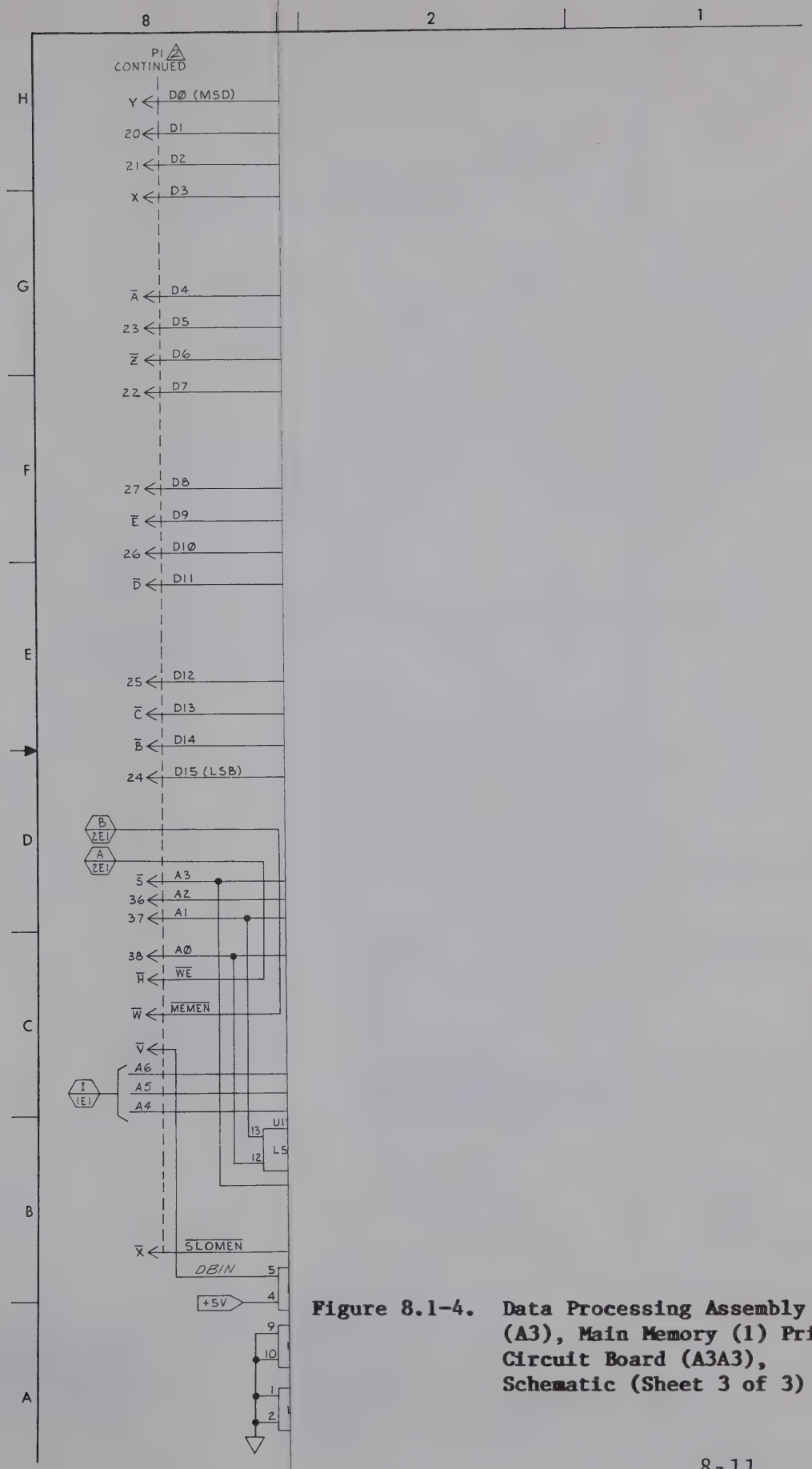


Figure 8.1-4. Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic (Sheet 3 of 3)

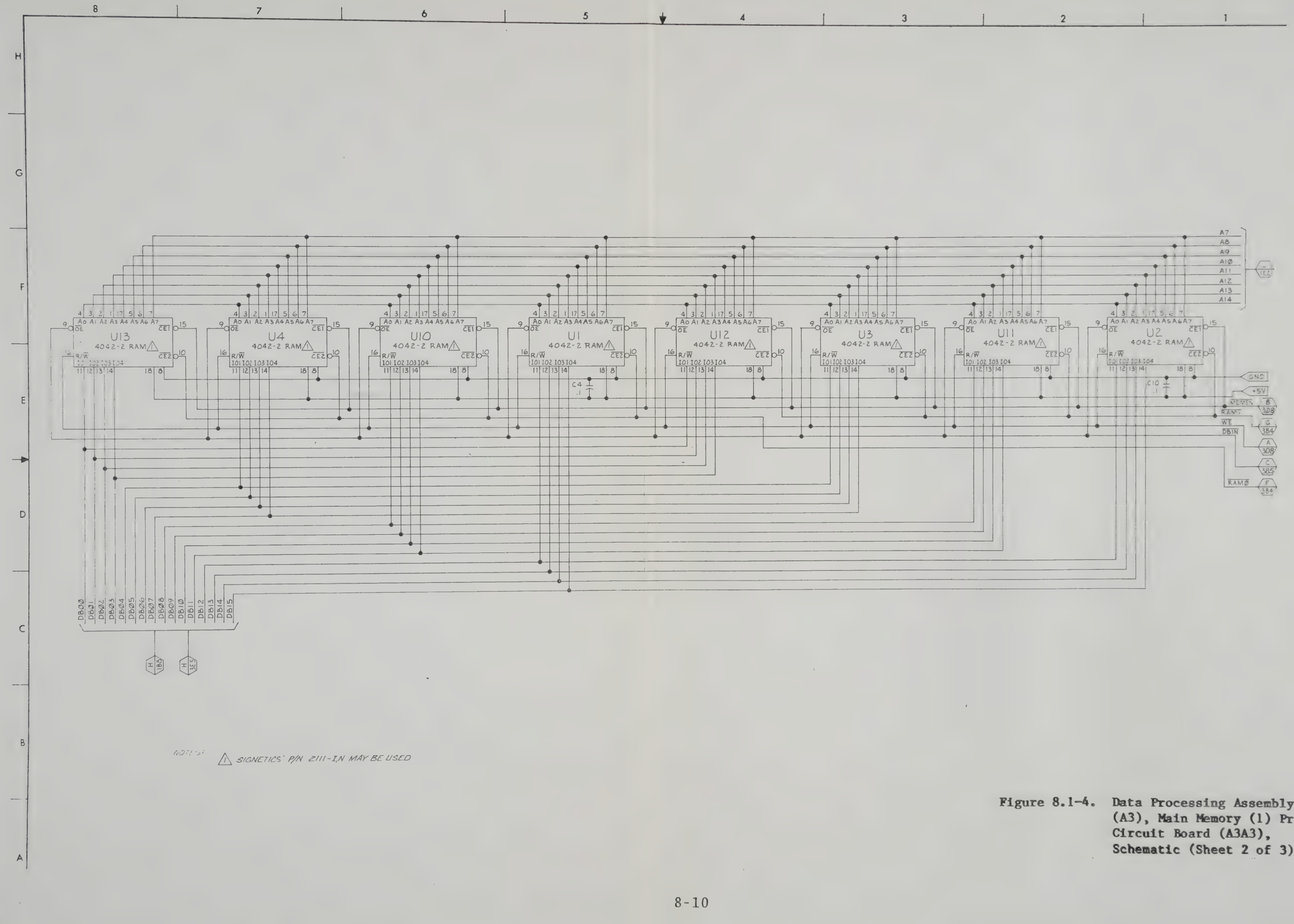


Figure 8.1-4. Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic (Sheet 2 of 3)

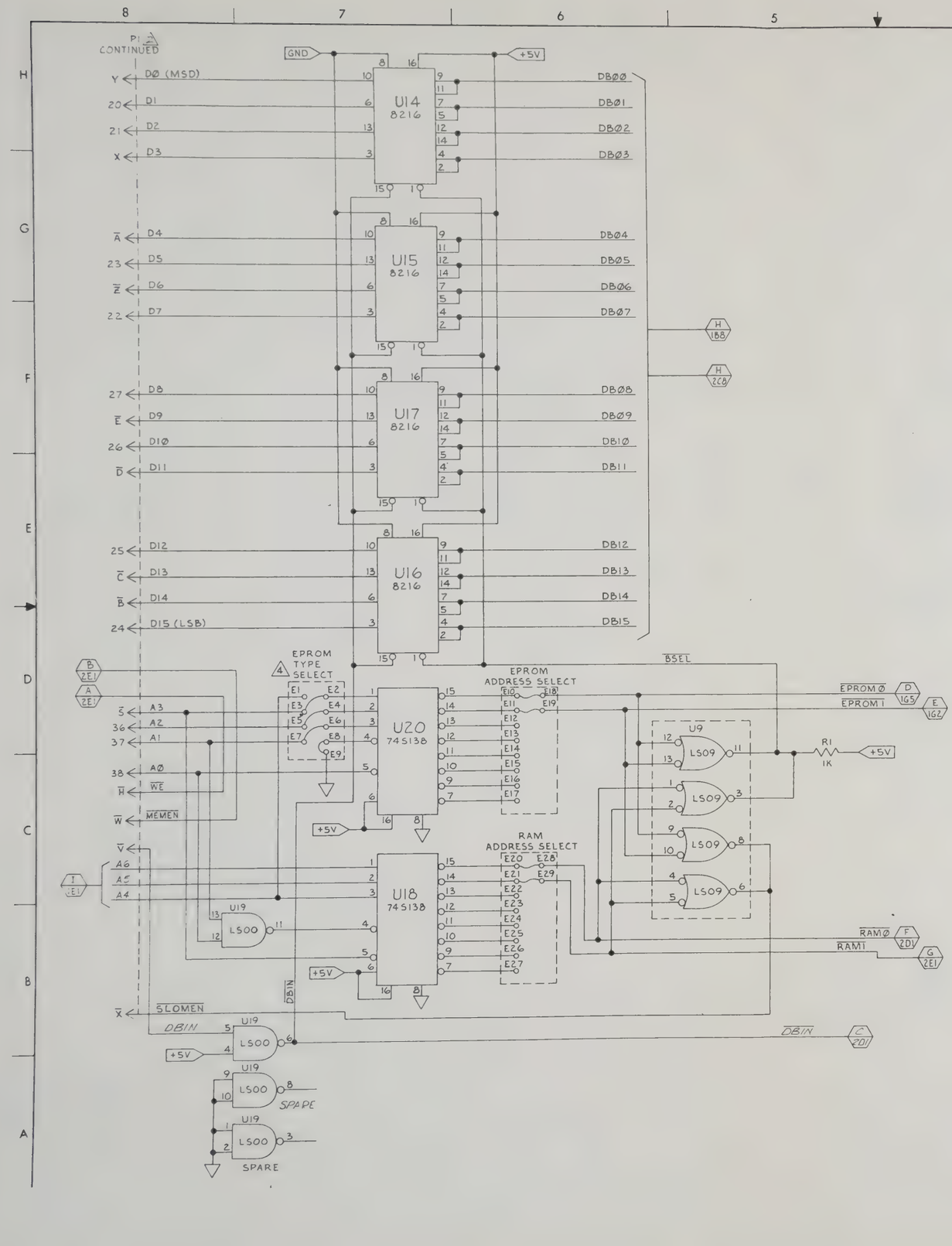


Figure 8.1-4. Data Processing Assembly (A3), Main Memory (1) Printed Circuit Board (A3A3), Schematic (Sheet 3 of 3)

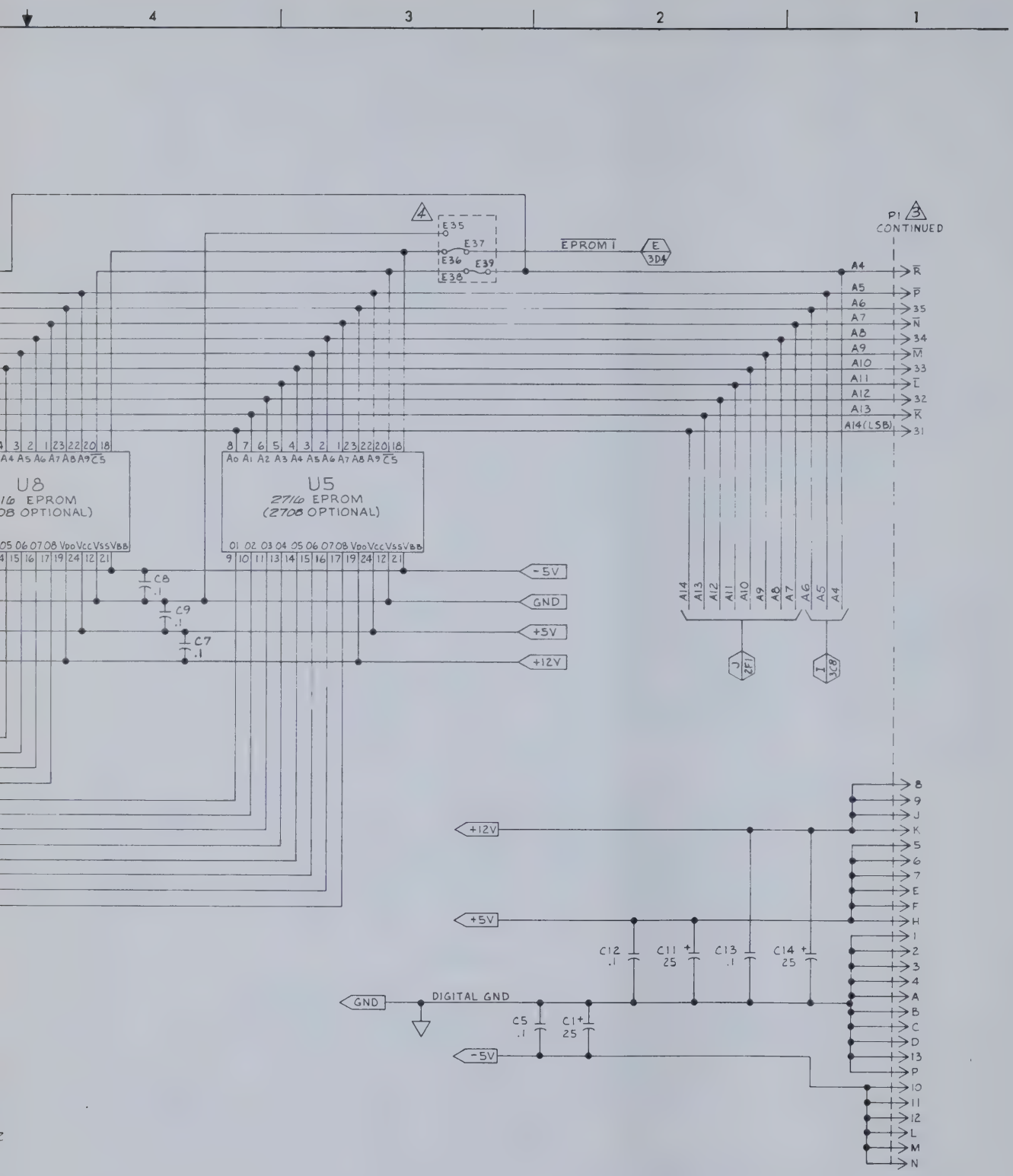


Figure 8.1-5. Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 1 of 3)

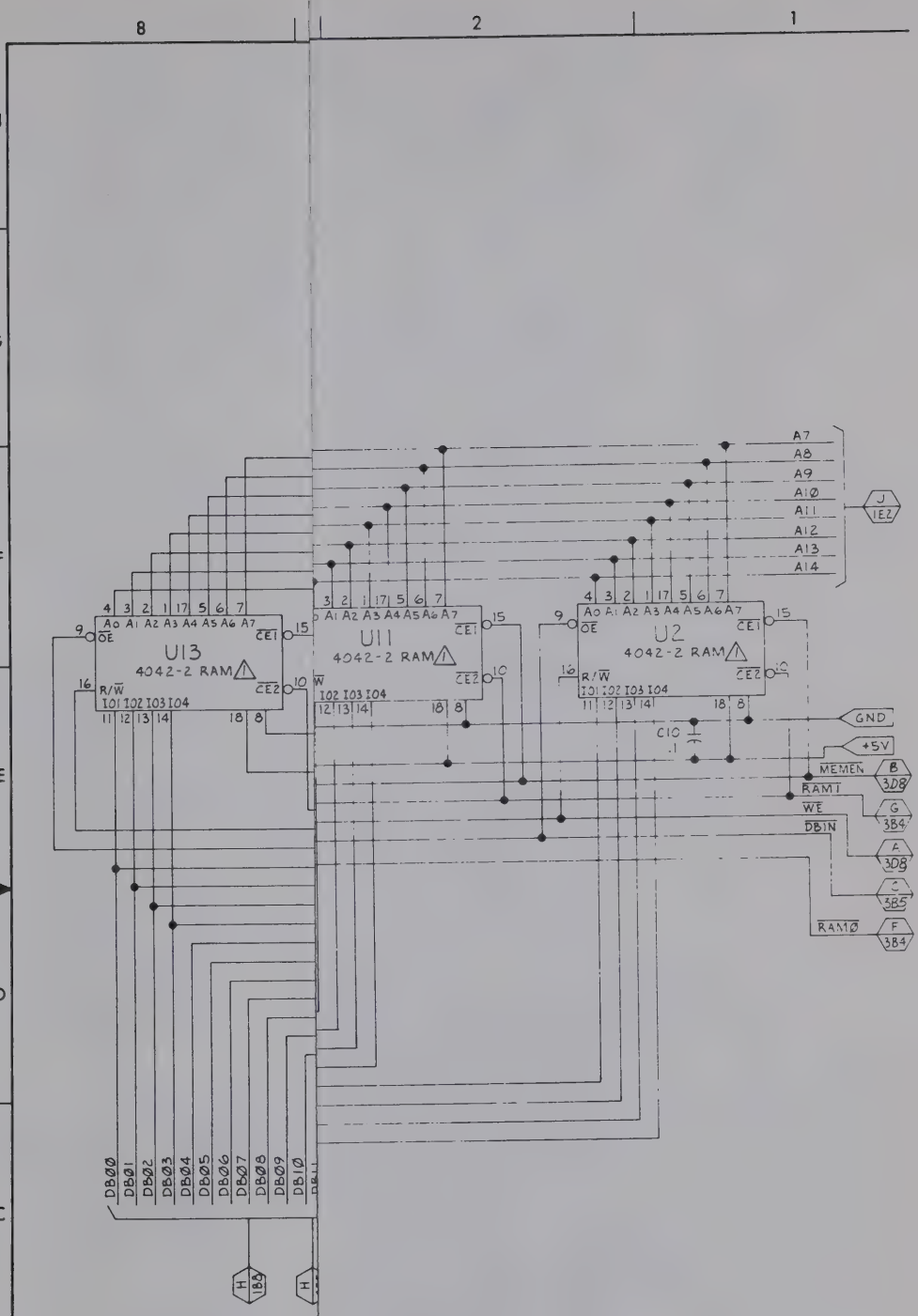
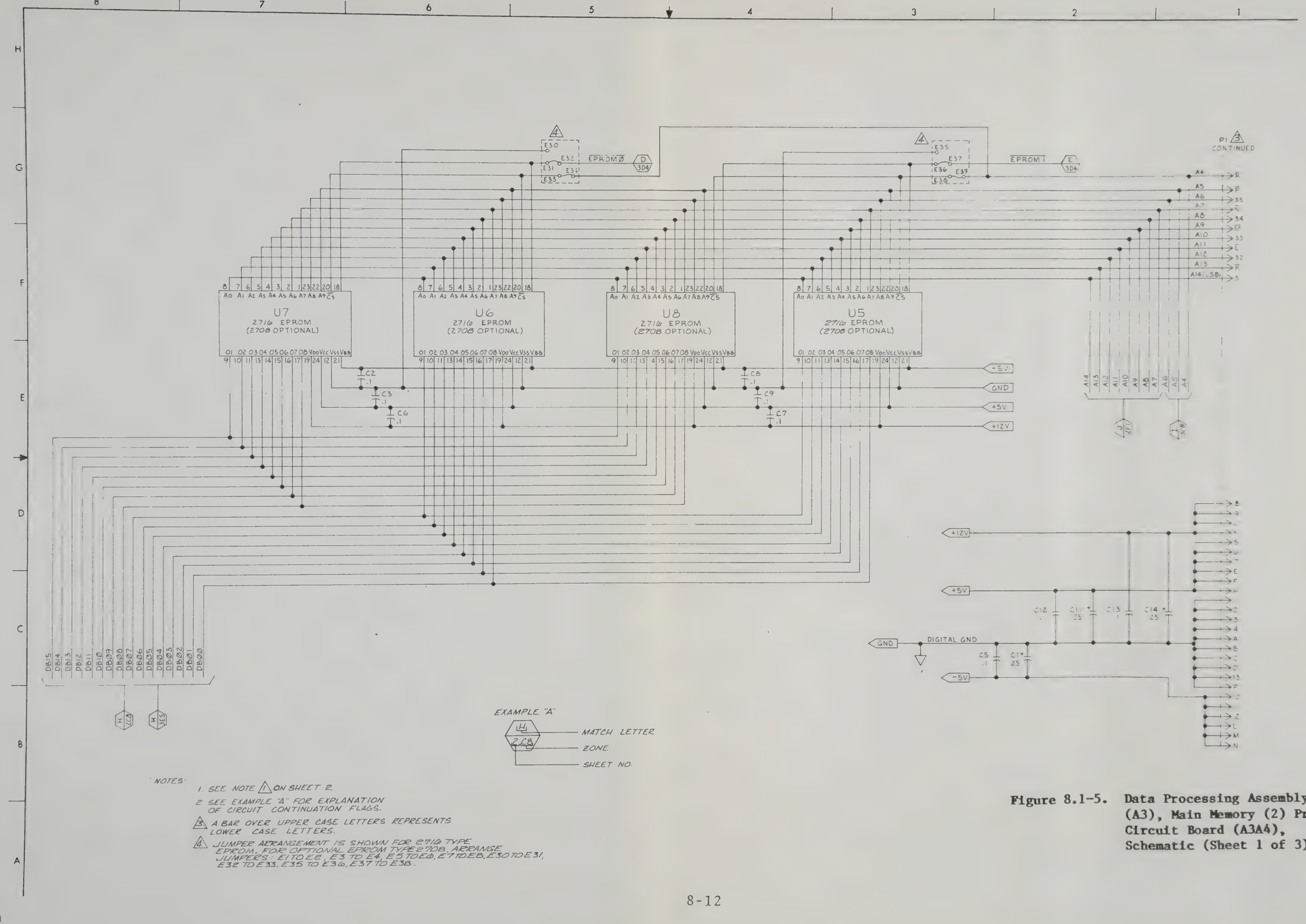


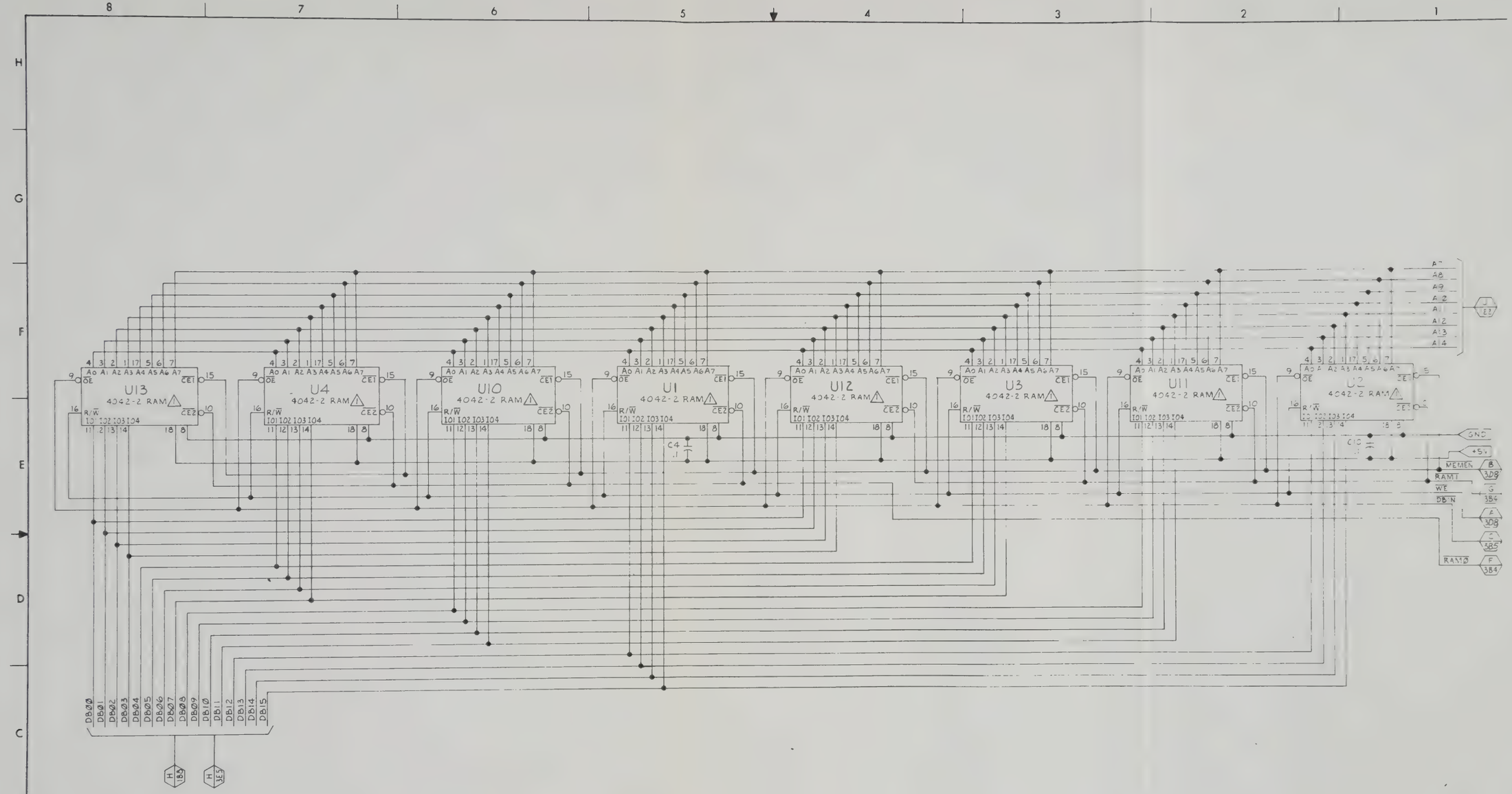
Figure 8.1-5. Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 2 of 3)



NOTES:

1. SEE NOTE 1 ON SHEET 2.
2. SEE EXAMPLE "A" FOR EXPLANATION OF CIRCUIT CONTINUATION FLAGS.
3. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
4. JUMPER ARRANGEMENT IS SHOWN FOR 2716 TYPE EPROM. FOR OPTIONAL EPROM TYPE 2708, ARRANGE JUMPERS: E1 TO E2, E3 TO E4, E5 TO E6, E7 TO E8, E30 TO E31, E32 TO E33, E35 TO E36, E37 TO E38.

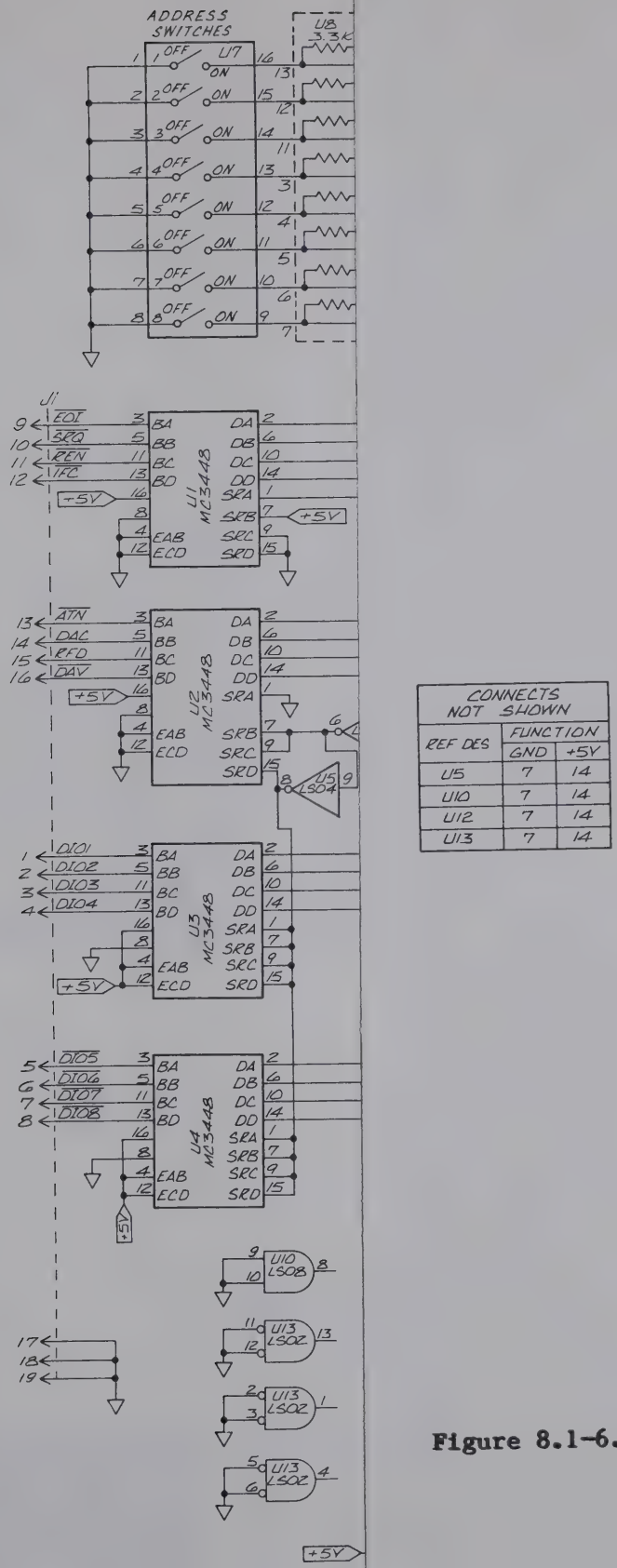
Figure 8.1-5. Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 1 of 3)



NOTE: ⚠ SIGNETICS P/N 2111-1,N MAY BE USED.

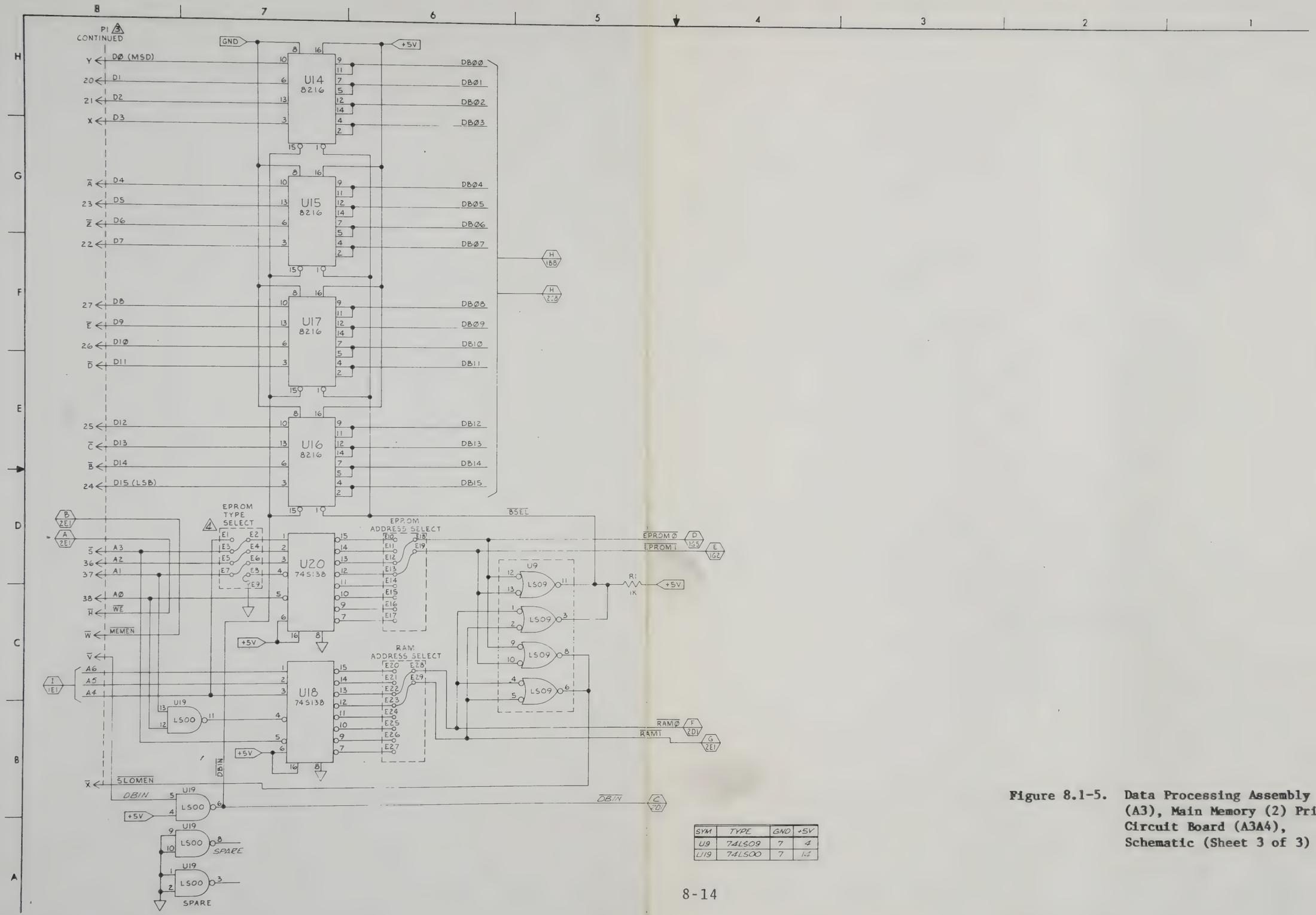
Figure 8.1-5. Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 2 of 3)

Figure 8.1-5. Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 3 of 3)



CONNECTS NOT SHOWN		
REF DES	FUNCTION	
	GND	+5V
U5	7	14
U10	7	14
U12	7	14
U13	7	14

Figure 8.1-6. Data Processing Assembly (A3), Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic



SYM	TYPE	GND	+5V
U9	74LS09	7	4
U19	74LS00	7	14

Figure 8.1-5. Data Processing Assembly (A3), Main Memory (2) Printed Circuit Board (A3A4), Schematic (Sheet 3 of 3)

CONNECTS NOT SHOWN		
REF DES	FUNCTION	
	GND	+5V
U5	7	14
U10	7	14
U12	7	14
U13	7	14

Figure 8.1-6. Data Processing Assembly (A3), Optional IEEE-488 Interface Printed Circuit Board (A3A7), Schematic

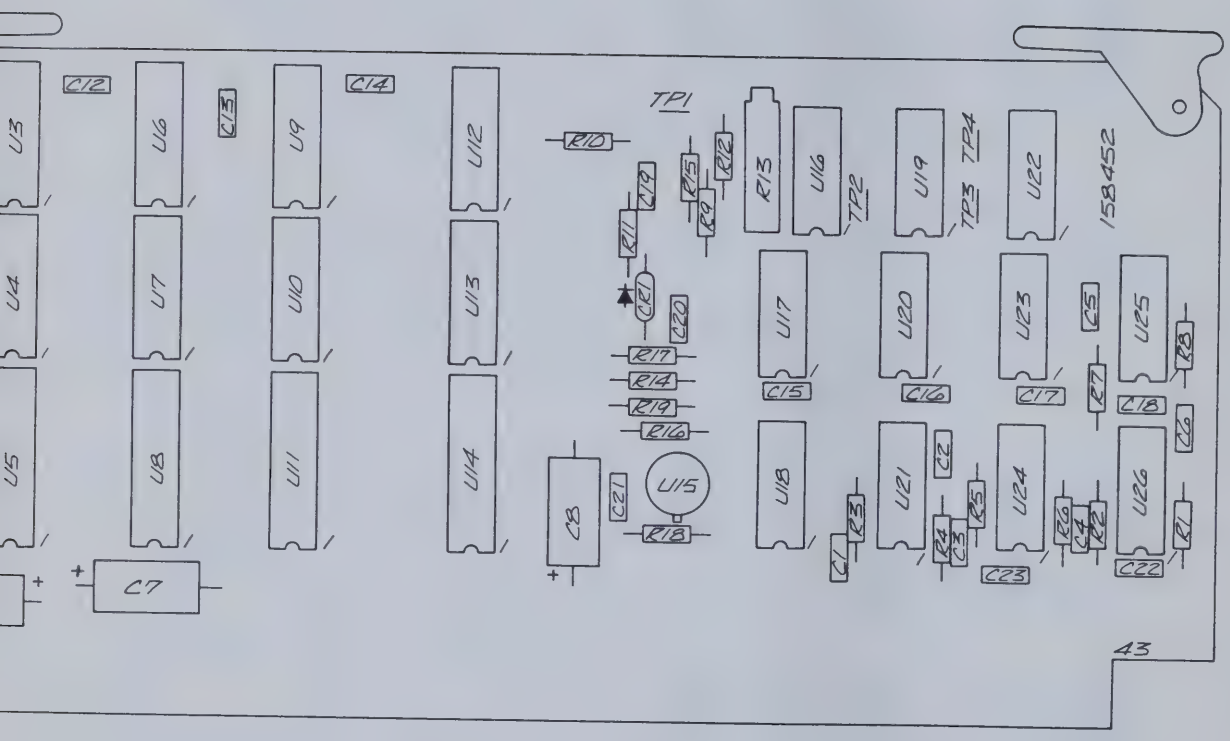


Figure 8.1-7. Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Component Location

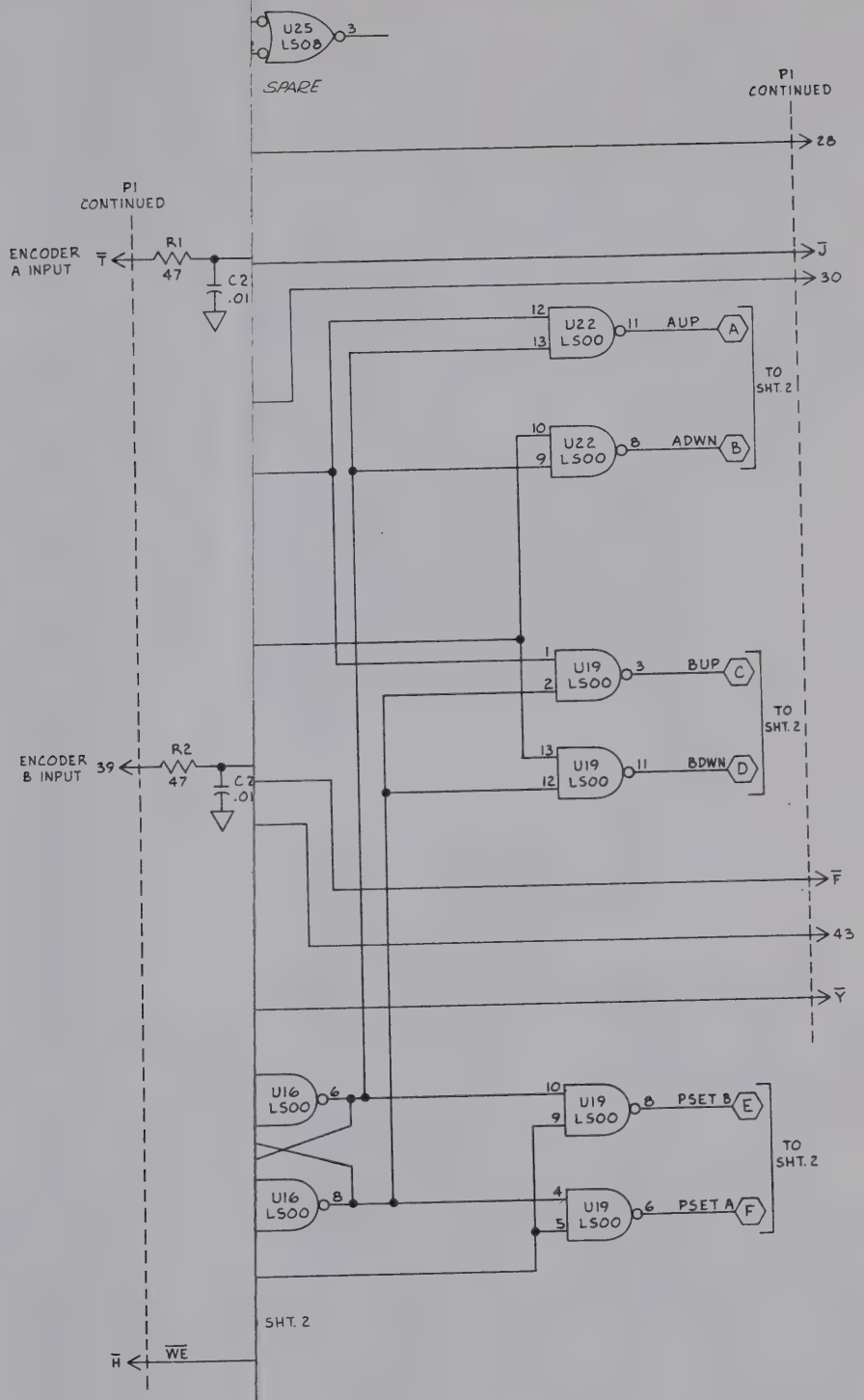


Figure 8.1-8. Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 1 of 2)

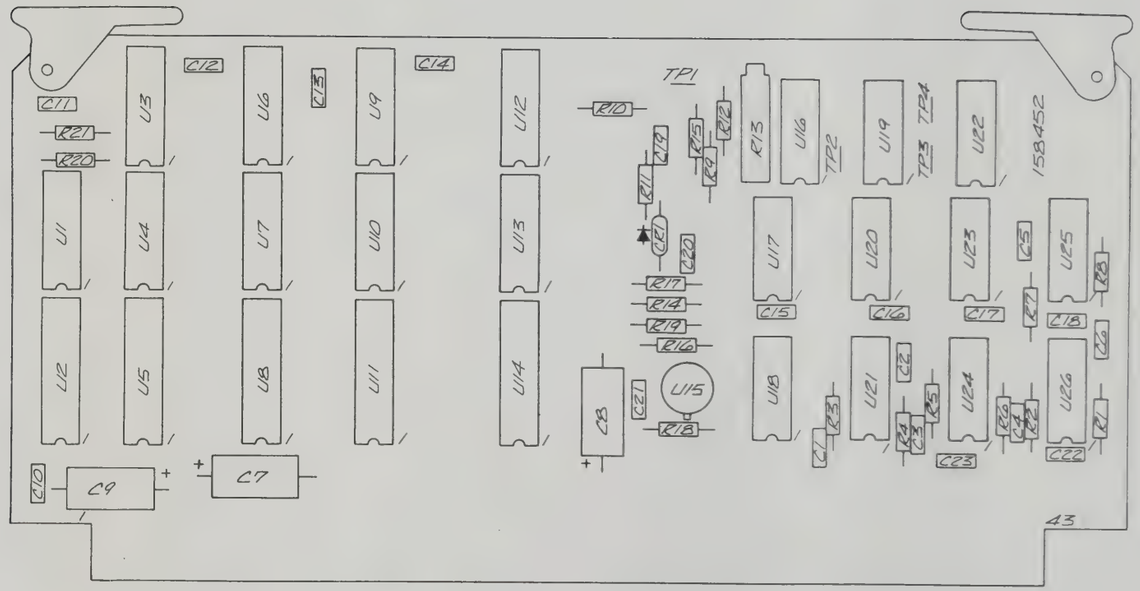
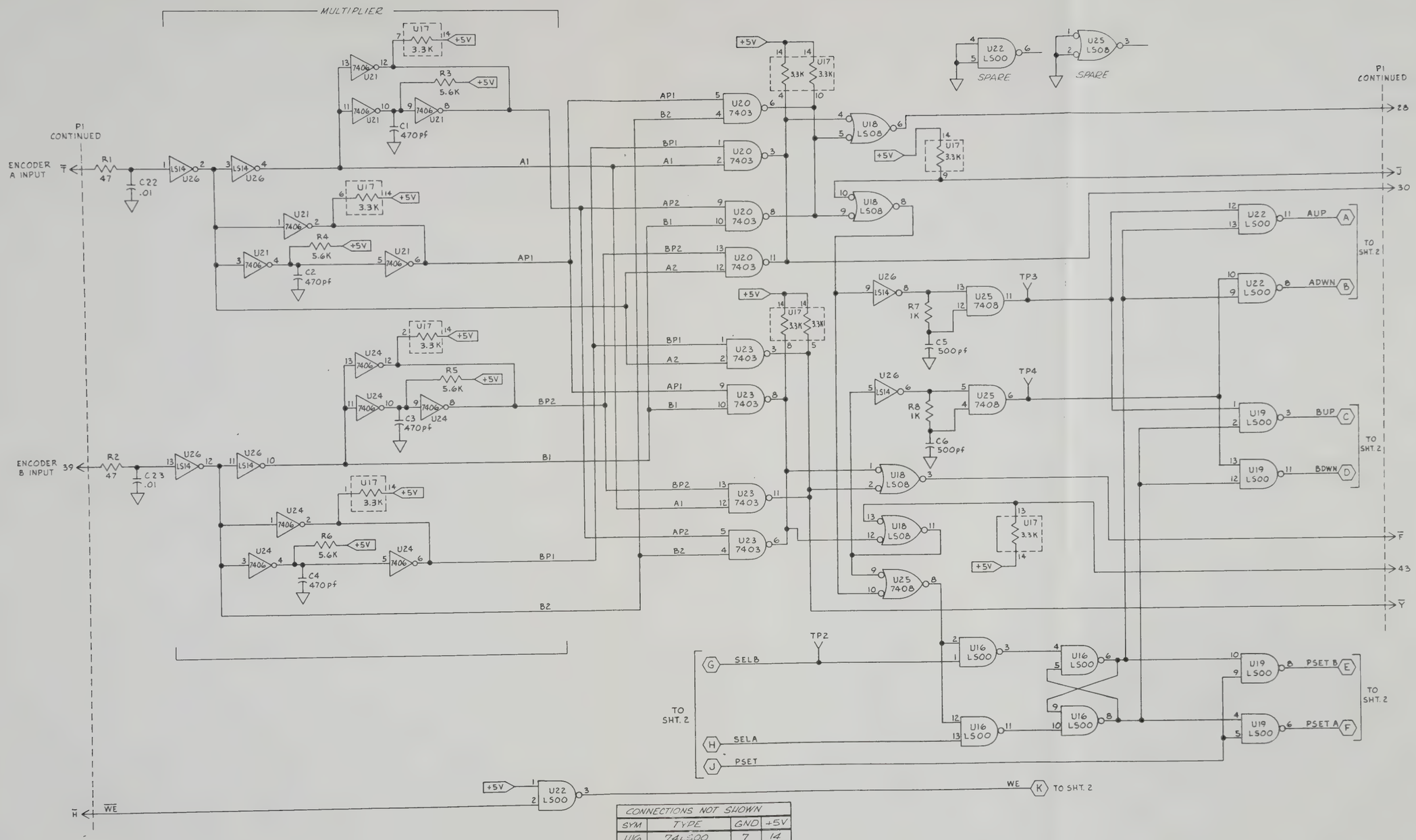


Figure 8.1-7. Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Component Location



CONNECTIONS NOT SHOWN			
SYM	TYPE	GND	+5V
U16	74LS00	7	14
U18	74LS08	7	14
U19	74LS00	7	14
U20	7403	7	14
U21	7406	7	14
U22	74LS00	7	14
U23	7403	7	14
U24	7406	7	14
U25	7408	7	14
U26	74LS14	7	14

NOTE: 1. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS

Figure 8.1-8. Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 1 of 2)

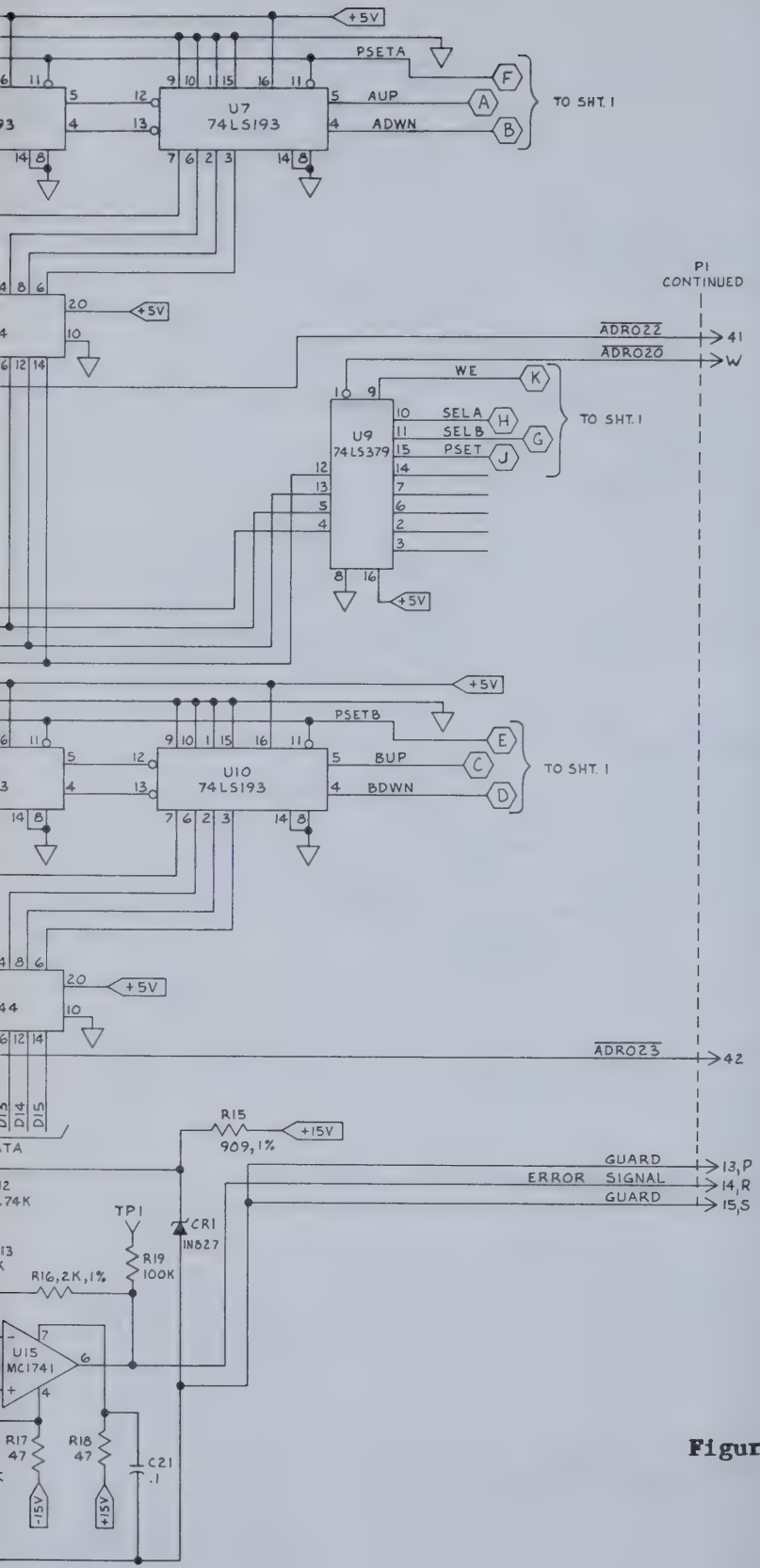


Figure 8.1-8. Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 2 of 2)

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89		10^{-3}	30		10^3
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^2	10^4
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88					
											10^{-5}	50		10^5
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39	10^{-3}	10^{-6}	60	10^3	10^6
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91		10^{-7}	70		10^7
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44	10^{-4}	10^{-8}	80	10^4	10^8
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99		10^{-9}	90		10^9
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55					
										10^{-5}	10^{-10}	100	10^5	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

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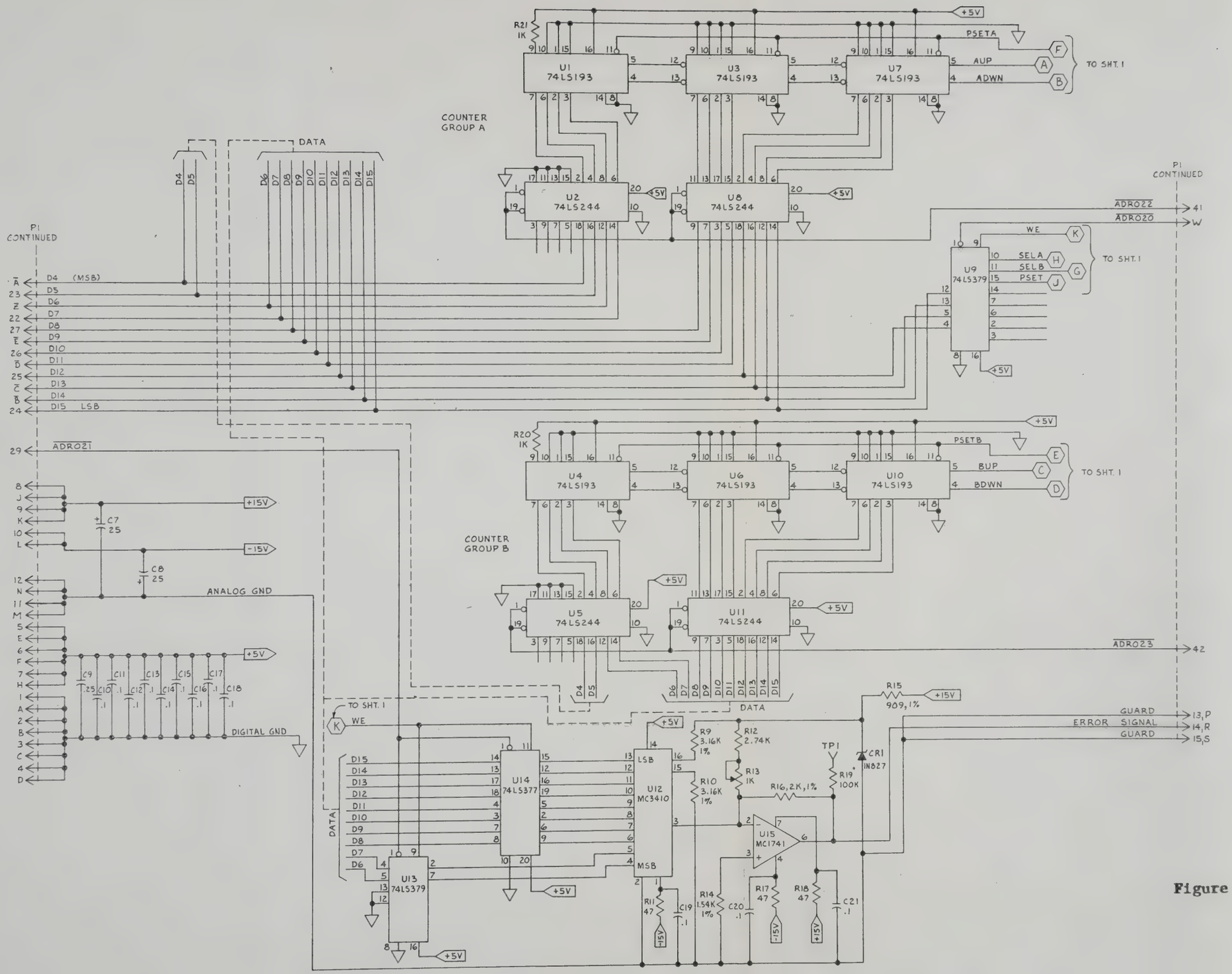

Figure 8.1-8. Data Processing Assembly (A3), Pen Control/Chart Control Printed Circuit Board (A3A9 and/or A3A10), Schematic (Sheet 2 of 2)

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42		10^{-3}	30		10^3
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89	10^{-2}	10^{-4}	40	10^2	10^4
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38		10^{-5}	50		10^5
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88	10^{-3}	10^{-6}	60	10^3	10^6
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39		10^{-7}	70		10^7
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91	10^{-4}	10^{-8}	80	10^4	10^8
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44		10^{-9}	90		10^9
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99	10^{-5}	10^{-10}	100	10^5	10^{10}
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55		10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

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Instruction Manual Update

Manual Update Information

This envelope is provided for filing manual update information such as corrections to text, tables, procedures, new or revised drawings, or special application notes. Please use your own filing method to list the update entries in the blank space below.

This is an interim step to provide our customers with both errata and new information for this equipment while the manual is being corrected. If you desire a corrected and revised manual when it becomes available, please write to:

Scientific-Atlanta, Inc.
Instrumentation Publications
3845 Pleasantdale Road
Atlanta, GA 30340

Specify the Manual Title, Publication No., and Printing Date as listed on the title page. Include the Equipment Model No. and Serial No. if available.

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Instruction Manual Update

DATE September, 1985

MANUAL NAME Series 1580 Pattern Recorder

Changes have occurred since the last printing of this manual. The attached pages are updated versions of those appearing in this book.

ECO NO. 7475I

Scientific Atlanta

INDEX

REF DESIG	Part No.	Title	Page
	163106	Recorder Assembly	6-4
A1	164722	Head Assembly	6-5
A1A1	160809	Head Sub-Assembly	6-6
A1A1A1	160808	Frame Assembly	6-7
A1A1A1A1	164723	Pen Motor & Encoder Assembly	6-8
A1A1A2	160807	Right Side Frame Assembly	6-9
A1A1A2A1	164724	Chart Motor & Encoder Assembly	6-10
A1A2	158388	Pen Calibrate PWB Assembly	6-11
A1A3	163041	Pen Control Panel Assembly	6-12
A1A4	163040	Chart Control Panel Assembly	6-13
A1A5	163103	Bottom Paper Sensor PWB Assembly	6-14
A2	163037	Power Supply Assembly	6-15
A2A1	158327	Regulator PWB Assembly	6-17
A2A2	219157	Chart & Pen Servo PWB Assembly	6-19
A3	158351	Data Processor Assembly	6-21
A3A1	151488	Control Panel Interface PWB Assembly	6-22
A3A2	156088	CPU PWB Assembly	6-23
(1) A3A3	317614	Memory 1 PWB Assembly	6-24
A3A4	256213	Memory 2 PWB Assembly	6-25
A3A5	158391	CBA/DCA Interface PWB Assembly	6-26
A3A5	158455	Digital Interface PWB Assembly	6-27
A3A6	151489	Synchro to Digital Converter PWB Assembly	6-28
A3A6	158455	Digital Interface PWB Assembly	6-29
A3A7	252588	IEEE-488 Interface PWB Assembly	6-30
A3A8	158501	60 dB Interface PWB Assembly	6-31
A3A9	158452	Pen/Chart Control PWB Assembly	6-32
A3A10	158452	Pen/Chart Control PWB Assembly	6-34
A3A11	162915	Servo Rate Loop PWB Assembly	6-36
A3A12	158363	Motherboard PWB Assembly	6-38
A5	163072	S/D Transformer Module Assembly	6-39
A5A1	158383	S/D Module PWB Assembly	6-40
A6	162121	Digital Interface Panel Assembly	6-41
		FSCM Manufacturer Cross Reference	6-42

(1)

REF DESIG	PART NUMBER	SERIAL NUMBER* FROM	TO
A3A3	156089	1	401
A3A3	256211	402	750
A3A3	317614	751	

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REF DESIG	Part No.	Title	Page
	163106	Recorder Assembly	6-4
A1	164722	Head Assembly	6-5
A1A1	160809	Head Sub-Assembly	6-6
A1A1A1	160808	Frame Assembly	6-7
A1A1A1A1	164723	Pen Motor & Encoder Assembly	6-8
A1A1A2	160807	Right Side Frame Assembly	6-9
A1A1A2A1	164724	Chart Motor & Encoder Assembly	6-10
A1A2	158388	Pen Calibrate PWB Assembly	6-11
A1A3	163041	Pen Control Panel Assembly	6-12
A1A4	163040	Chart Control Panel Assembly	6-13
A1A5	163103	Bottom Paper Sensor PWB Assembly	6-14
A2	163037	Power Supply Assembly	6-15
A2A1	158327	Regulator PWB Assembly	6-17
A2A2	219157	Chart & Pen Servo PWB Assembly	6-19
A3	158351	Data Processor Assembly	6-21
A3A1	151488	Control Panel Interface PWB Assembly	6-22
A3A2	156088	CPU PWB Assembly	6-23
(1) A3A3	317614	Memory 1 PWB Assembly	6-24
A3A4	256213	Memory 2 PWB Assembly	6-25
A3A5	158391	CBA/DCA Interface PWB Assembly	6-26
A3A5	158455	Digital Interface PWB Assembly	6-27
A3A6	151489	Synchro to Digital Converter PWB Assembly	6-28
A3A6	158455	Digital Interface PWB Assembly	6-29
A3A7	252588	IEEE-488 Interface PWB Assembly	6-30
A3A8	158501	60 dB Interface PWB Assembly	6-31
A3A9	158452	Pen/Chart Control PWB Assembly	6-32
A3A10	158452	Pen/Chart Control PWB Assembly	6-34
A3A11	162915	Servo Rate Loop PWB Assembly	6-36
A3A12	158363	Motherboard PWB Assembly	6-38
A5	163072	S/D Transformer Module Assembly	6-39
A5A1	158383	S/D Module PWB Assembly	6-40
A6	162121	Digital Interface Panel Assembly	6-41
		FSCM Manufacturer Cross Reference	6-42

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MEMORY 1 PWB ASSEMBLY - 317614 (1)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0156089	B PWB ASSY MEMORY 1 BOARD		
2	0317611	EPROM AND LABL ASSY 1580 MEM 1		

SUBASSEMBLY - 156089

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
	0163019	MEMORY BOARD SCHEMATIC	PER S A DWG	
1	0163020	PWB MEMORY BOARD	PER S A DWG	
2	0082463	EXTRACTOR PC BOARD	5005-08N	13103
3	0078469	PIN SPRING 3/32 DIA X 1/4 LG SLTD CD P	PER MS16562-21	
C1	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C3	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C11	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C13	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C14	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
R1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
U1	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U2	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U3	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U4	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U9	0086647	IC TTL GATE AND 2-IN QUAD OPEN COL	SN74LS09N	
U10	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U11	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U12	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U13	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U14	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U15	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U16	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U17	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U18	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
U19	0084279	IC TTL GATE NAND 2-IN QUAD	SN74LS00N	01295
U20	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
XU1	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU2	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU3	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU4	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU5	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU6	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU7	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU8	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU9	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU10	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU11	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU12	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU13	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU14	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU15	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU16	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU17	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU18	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU19	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU20	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	

(1) SEE PAGE 6-24a

MEMORY 1 PWB ASSEMBLY - 317614 (1)

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
1	0156089	B PWB ASSY MEMORY 1 BOARD		
2	0317611	EPROM AND LABL ASSY 1580 MEM 1		

SUBASSEMBLY - 156089

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
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1	0163020	PWB MEMORY BOARD	PER S A DWG	
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C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C11	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C13	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C14	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
R1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
U1	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U2	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U3	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U4	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U9	0086647	IC TTL GATE AND 2-IN QUAD OPEN COL	SN74LS09N	
U10	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U11	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U12	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U13	0170267	IC MEMORY NMOS RAM 256X4 450 NS STATIC	9111BDC	
U14	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U15	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U16	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U17	0084030	IC BUS TRANSCVR 4-BIT 3-STATE TTL	P8216	
U18	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
U19	0084279	IC TTL GATE NAND 2-IN QUAD	SN74LS00N	01295
U20	0085943	IC TTL DECODER 3-BIT TO 1 OF 8	SN74LS138N	
XU1	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU2	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU3	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU4	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU5	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU6	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU7	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU8	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU9	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU10	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU11	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU12	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU13	0086650	SOCKET 18 PIN DIP PC MT	ICT-183-S-T	
XU14	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU15	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU16	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU17	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU18	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	
XU19	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU20	0086649	SOCKET 16 PIN DIP PC MT	ICT-163-S-T	

(1) SEE PAGE 6-24a

SUBASSEMBLY - 156089 (Continued)

(1)

SERIAL NUMBER*		PWB ASSEMBLY NUMBER	ITEM 2 PART NUMBER
FROM	TO		
1	401	156089	156088
402	750	256211	256210
751		317614	317611

*SERIAL NUMBER APPROXIMATE

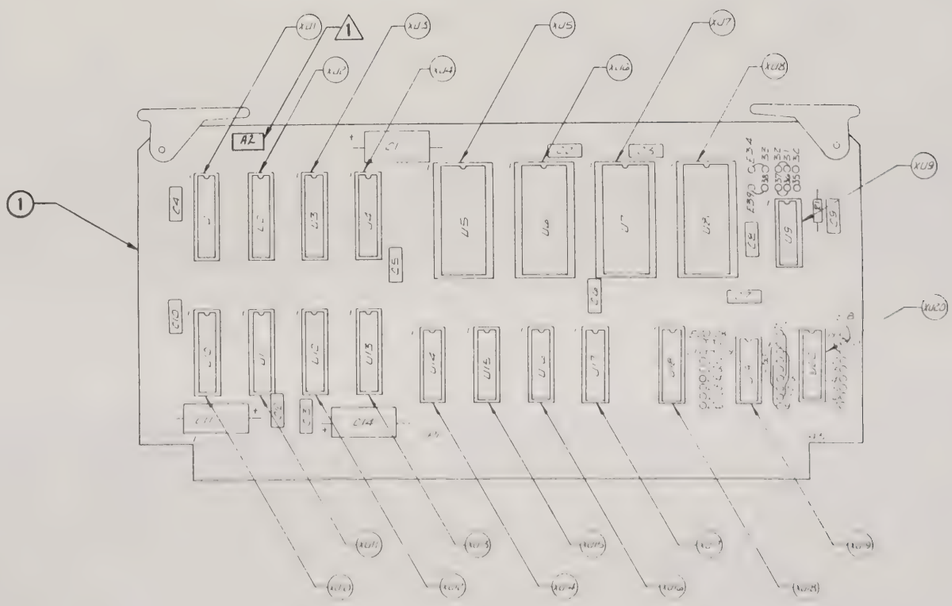
SUBASSEMBLY - 156089 (Continued)

(1)

SERIAL NUMBER*		PWB ASSEMBLY NUMBER	ITEM 2 PART NUMBER
FROM	TO		
1	401	156089	156088
402	750	256211	256210
751		317614	317611

*SERIAL NUMBER APPROXIMATE

1580

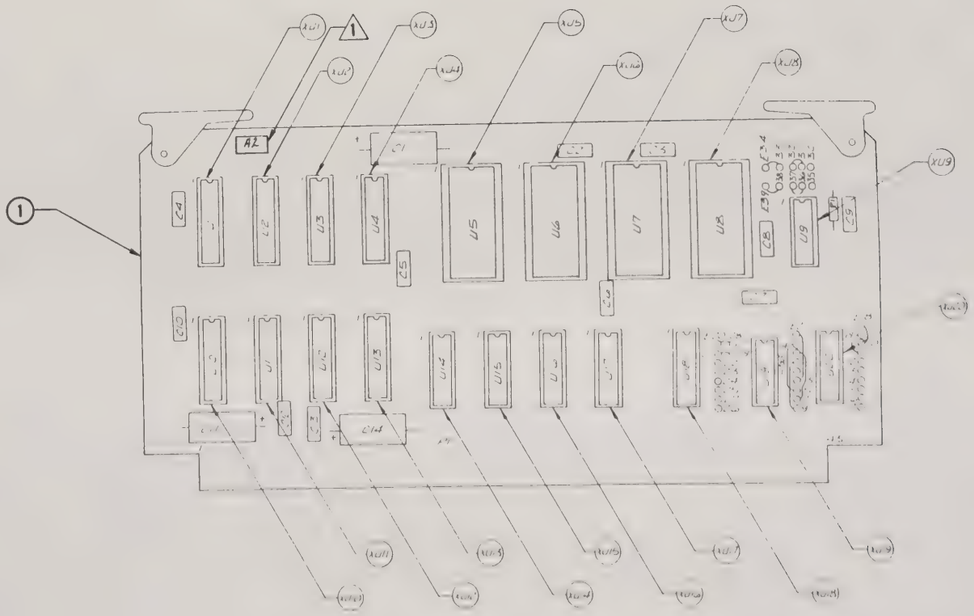


⚠1 ASSEMBLY NUMBER	SERIAL NUMBER*	
	FROM	TO
256211	402	750
317614	751	

*SERIAL NUMBER APPROXIMATE

Figure 7-27a. Main Memory (1) Printed Circuit Board (A3A3), Component Location

1580


1
A2
U1
U2
U3
U4
U5
U6
U7
U8
U9
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40

Instruction Manual Update

DATE August, 1985

MANUAL NAME Series 1580 Pattern Recorder

Changes have occurred since the last printing of this manual. The attached pages are updated versions of those appearing in this book.

ECO NO. 7202I

Scientific Atlanta

Instruction Manual Update

DATE August, 1985

MANUAL NAME Series 1580 Pattern Recorder

Changes have occurred since the last printing of this manual. The attached pages are updated versions of those appearing in this book.

ECO NO. 7202I

Scientific Atlanta

PWB ASSY CPU BOARD - 156088

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
	0163017	CPU BOARD SCHEMATIC	PER S A DWG	
1	0312178	PWB-CPU	PER SA DWG	
C1	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	DD102	71590
(1) C2	0073493	CAPACITR 18 PF 500V SILVER MICA 5%	CD15CD180J03	14655
(2) C2	0073492	CAPCITR 15 PF 500V SILVER MICA 5%	CD15CD150J03	00656
(5) C2	0077965	CAPACITR 51 PF 500V SILVER MICA 2%	CD6ED510G03	14655
C3	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	DD102	71590
C4	0078998	CAPACITR 5 MF 25V	500D505G025BA7	80183
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C8	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C10	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
CR1	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
(3) L1	0077954	INDUCTOR .47 UH SUBMIN UNSHLD 10%	IR-2	91637
(2) LI	0078718	INDUCTOR .429 - 517 UH PC MOUNT	7107-09	
(5) L1	0078833	INDUCTOR 2.97-3.63 UH PC MT	7107 19	71279
R1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R2	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R3	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
(4) R4	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	
(5) R4	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R5	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R6	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R7	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R8	0072093	RESISTOR 68K OHM 1/4W 10% COMP	RCR07G683KS	01121
R9	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R10	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R11	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R12	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R13	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R14	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R15	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
U1	0217704	HEAT SINK ASSY,1581 SP PRTKT		
U2	0084285	IC TTL GATE OR 2-IN QUAD	SN74LS32N	01295
U3	0084028	IC I/O PORT 8-BIT 3-STATE TTL	P8212	
U4	0084028	IC I/O PORT 8-BIT 3-STATE TTL	P8212	
U5	0087078	IC MICROPROCESSOR 16-BIT NMOS	TMS9900	
U6	0084028	IC I/O PORT 8-BIT 3-STATE TTL	P8212	
U7	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
U8	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
U9	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
U10	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
XU1	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU2	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU3	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU4	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU5	0087081	SOCKET 64 PIN DIP PC MT	ICN-649-S5-G	
XU6	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU7	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU8	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU9	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU10	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
Y1	0317058	CRYSTAL 12.0MHZ .005%	PER DWG	

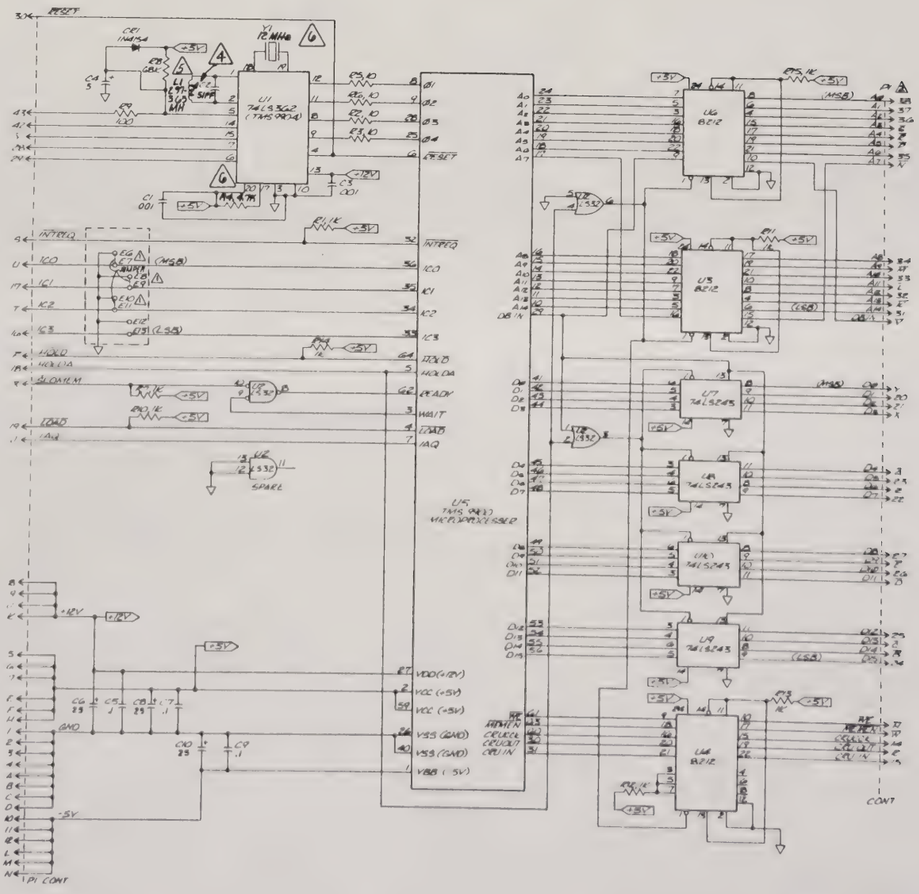
(1) APPLIES TO SERIAL NUMBER 324 AND BELOW (APPROXIMATELY).
(2) APPLIES TO SERIAL NUMBER 325 THROUGH 741 (APPROXIMATELY).
(3) APPLIES TO SERIAL NUMBER 551 AND BELOW (APPROXIMATELY).
(4) APPLIES TO SERIAL NUMBER 741 AND BELOW (APPROXIMATELY).
(5) APPLIES TO SERIAL NUMBER 742 AND ABOVE (APPROXIMATELY).

PWB ASSY CPU BOARD - 156088

REF DESIG	PART NO.	DESCRIPTION	VENDOR PART NUMBER	FSCM CODE
	0163017	CPU BOARD SCHEMATIC	PER S A DWG	
1	0312178	PWB-CPU	PER SA DWG	
C1	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	DD102	71590
(1) C2	0073493	CAPACITR 18 PF 500V SILVER MICA 5%	CD15CD180J03	14655
(2) C2	0073492	CAPCITR 15 PF 500V SILVER MICA 5%	CD15CD150J03	00656
(5) C2	0077965	CAPACITR 51 PF 500V SILVER MICA 2%	CD6ED510G03	14655
C3	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	DD102	71590
C4	0078998	CAPACITR 5 MF 25V	500D505G025BA7	80183
C5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C6	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C8	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
C9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	8131-050-651-104Z	72982
C10	0070651	CAPACITR 25 MF 25V	500D256G025CB7	80183
CR1	0071142	DIODE 1N4154 SIL 25V 150MA	1N4154	80368
(3) L1	0077954	INDUCTOR .47 UH SUBMIN UNSHLD 10%	IR-2	91637
(2) LI	0078718	INDUCTOR .429 - 517 UH PC MOUNT	7107-09	
(5) L1	0078833	INDUCTOR 2.97-3.63 UH PC MT	7107 19	71279
R1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R2	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R3	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
(4) R4	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	
(5) R4	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	RCR07G472KS	01121
R5	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R6	0071836	RESISTOR 10 OHM 1/4W 10% COMP	RCR07G100KS	01121
R7	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R8	0072093	RESISTOR 68K OHM 1/4W 10% COMP	RCR07G683KS	01121
R9	0071887	RESISTOR 100 OHM 1/4W 10% COMP	RCR07G101KS	01121
R10	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R11	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R12	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R13	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R14	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
R15	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	RCR07G102KS	01121
U1	0217704	HEAT SINK ASSY,1581 SP PRTKT		
U2	0084285	IC TTL GATE OR 2-IN QUAD	SN74LS32N	01295
U3	0084028	IC I/O PORT 8-BIT 3-STATE TTL	P8212	
U4	0084028	IC I/O PORT 8-BIT 3-STATE TTL	P8212	
U5	0087078	IC MICROPROCESSOR 16-BIT NMOS	TMS9900	
U6	0084028	IC I/O PORT 8-BIT 3-STATE TTL	P8212	
U7	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
U8	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
U9	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
U10	0087076	IC BUS TRANSCVR 4-BIT 3-STATE TTL	SN74LS243N	
XU1	0086897	SOCKET 20 PIN DIP PC MT	ICT-203-S-T	
XU2	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU3	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU4	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU5	0087081	SOCKET 64 PIN DIP PC MT	ICN-649-S5-G	
XU6	0086651	SOCKET 24 PIN DIP PC MT	ICT-246-S-T	
XU7	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU8	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU9	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
XU10	0086648	SOCKET 14 PIN DIP PC MT	ICT-143-S-T	
Y1	0317058	CRYSTAL 12.0MHZ .005%	PER DWG	

(1) APPLIES TO SERIAL NUMBER 324 AND BELOW (APPROXIMATELY).
(2) APPLIES TO SERIAL NUMBER 325 THROUGH 741 (APPROXIMATELY).
(3) APPLIES TO SERIAL NUMBER 551 AND BELOW (APPROXIMATELY).
(4) APPLIES TO SERIAL NUMBER 741 AND BELOW (APPROXIMATELY).
(5) APPLIES TO SERIAL NUMBER 742 AND ABOVE (APPROXIMATELY).

1580

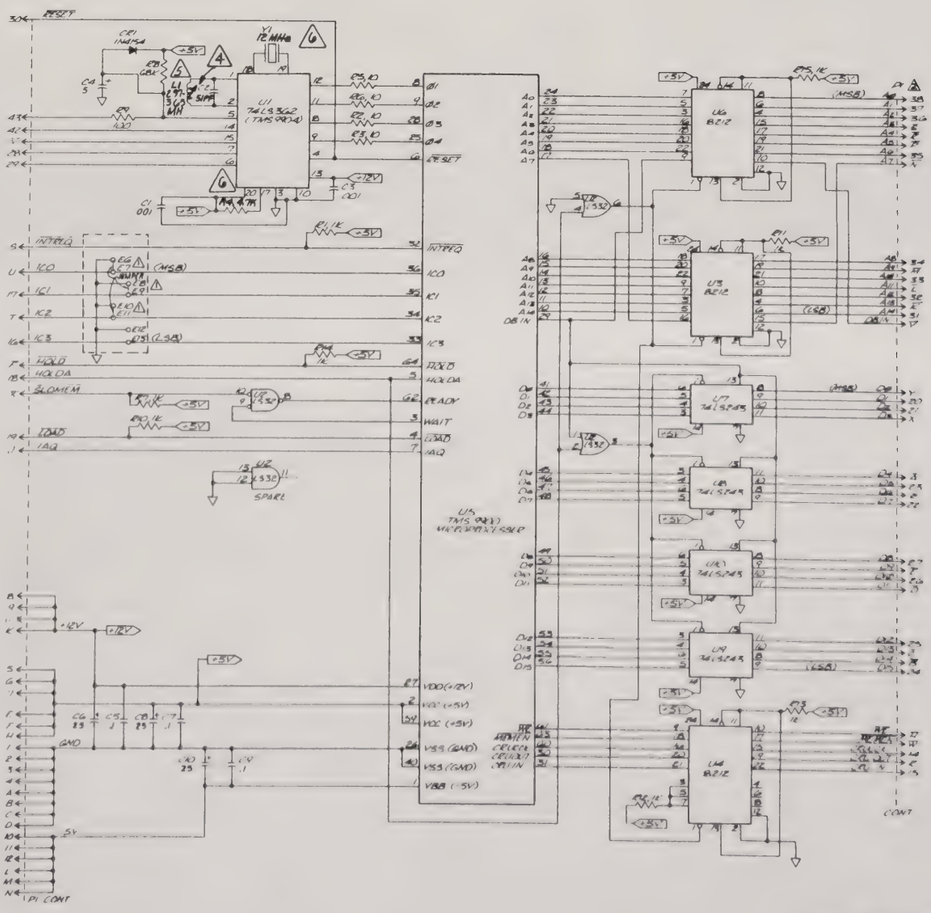


NOTES:

1. UNUSED INTERRUPTS MUST BE TIED TO GROUND.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
3. U2 POWER IS PIN 14 & GROUND IS PIN 7.
4. C2 VALUE IS 18PF ON SERIAL NUMBER 324 AND BELOW, AND 15 PF ON SERIAL NUMBER 325 THROUGH 741 (APPROXIMATELY).
5. L1 VALUE IS .47MH ON SERIAL NUMBER 551 AND BELOW, AND .429 - .517 MH ON SERIAL NUMBER 552 THROUGH 741 (APPROXIMATELY).
6. THE VALUE OF R4 IS 1K OHM AND Y1 IS 4800Hz ON SERIAL NUMBER 741 AND BELOW (APPROXIMATELY).

Figure 7-26. Central Processor Unit (CPU) Printed Circuit Board (A3A2), Schematic

1580



NOTES:

1. UNUSED INTERRUPTS MUST BE TIED TO GROUND.
2. A BAR OVER UPPER CASE LETTERS REPRESENTS LOWER CASE LETTERS.
3. U2 POWER IS PIN 14 & GROUND IS PIN 7.
4. C2 VALUE IS 18PF ON SERIAL NUMBER 324 AND BELOW, AND 15 PF ON SERIAL NUMBER 325 THROUGH 741 (APPROXIMATELY).
5. L1 VALUE IS .47MH ON SERIAL NUMBER 551 AND BELOW, AND .429 - .517 MH ON SERIAL NUMBER 552 THROUGH 741 (APPROXIMATELY).
6. THE VALUE OF R4 IS 1K OHM AND Y1 IS 4810Hz ON SERIAL NUMBER 741 AND BELOW (APPROXIMATELY).

Figure 7-26. Central Processor Unit (CPU) Printed Circuit Board (A3A2), Schematic

Instruction Manual Update

DATE March, 1984

MANUAL NAME Series 1580 Pattern Recorder

Changes have occurred since the last printing of this manual. The attached pages are updated versions of those appearing in this book.

DCN NO. 5099E

Scientific Atlanta

Instruction Manual Update

DATE March, 1984

MANUAL NAME Series 1580 Pattern Recorder

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DCN NO. 5099E

Scientific Atlanta

1580

HEAD ASSEMBLY-164722

REF DESIG PREFIX A1

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO-----
A1	160809	HEAD SUB-ASSY		
A2	158388	PWB ASSY PEN CALIBRATE		
A3	163041	PANEL ASSY PEN CONTROL		
A4	163040	PANEL ASSY CHART CONTROL		
A5	163103	PWB ASSY SENSOR PAPER BOTTOM		
(1) K1	87071	RELAY SOLID STATE SPST 140V 8A CONTACTS	W2QX-1	
K1	312856	RELAY ASSEMBLY		
W1	163104	CABLE ASSY		
W2	163105	CABLE ASSY		

(1) APPLIES TO SERIAL NUMBER 579 AND BELOW (APPROXIMATELY).

1580

HEAD ASSEMBLY-164722

REF DESIG PREFIX A1

COMP DESIG	S-A PART NO	----------DESCRIPTION----------	FSCM	-----MFR PART NO-----
A1	160809	HEAD SUB-ASSY		
A2	158388	PWB ASSY PEN CALIBRATE		
A3	163041	PANEL ASSY PEN CONTROL		
A4	163040	PANEL ASSY CHART CONTROL		
A5	163103	PWB ASSY SENSOR PAPER BOTTOM		
(1) K1	87071	RELAY SOLID STATE SPST 140V 8A CONTACTS	W2QX-1	
K1	312856	RELAY ASSEMBLY		
W1	163104	CABLE ASSY		
W2	163105	CABLE ASSY		

(1) APPLIES TO SERIAL NUMBER 579 AND BELOW (APPROXIMATELY).

1580

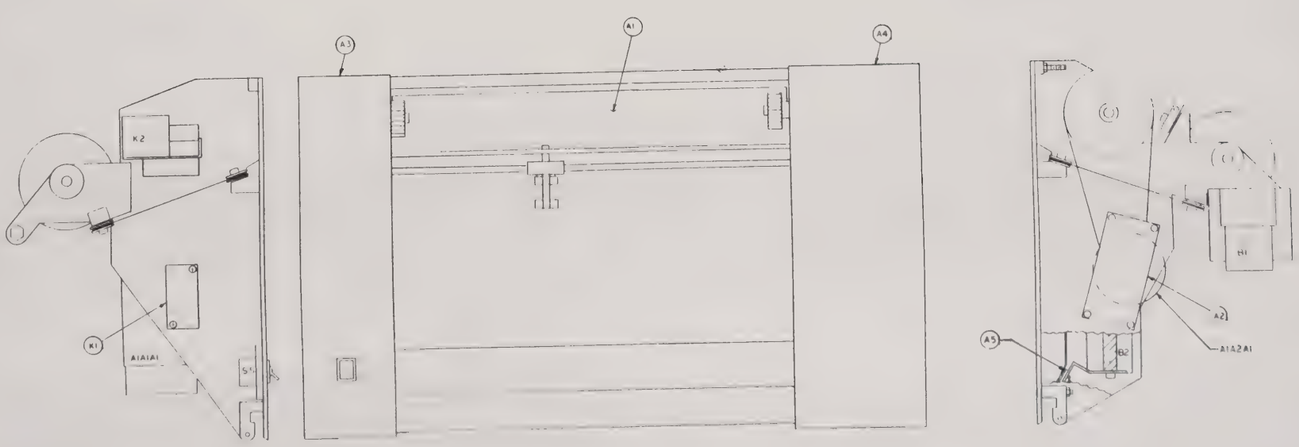

Figure 7-4. Recorder Head Assembly (A1), Outline Drawing

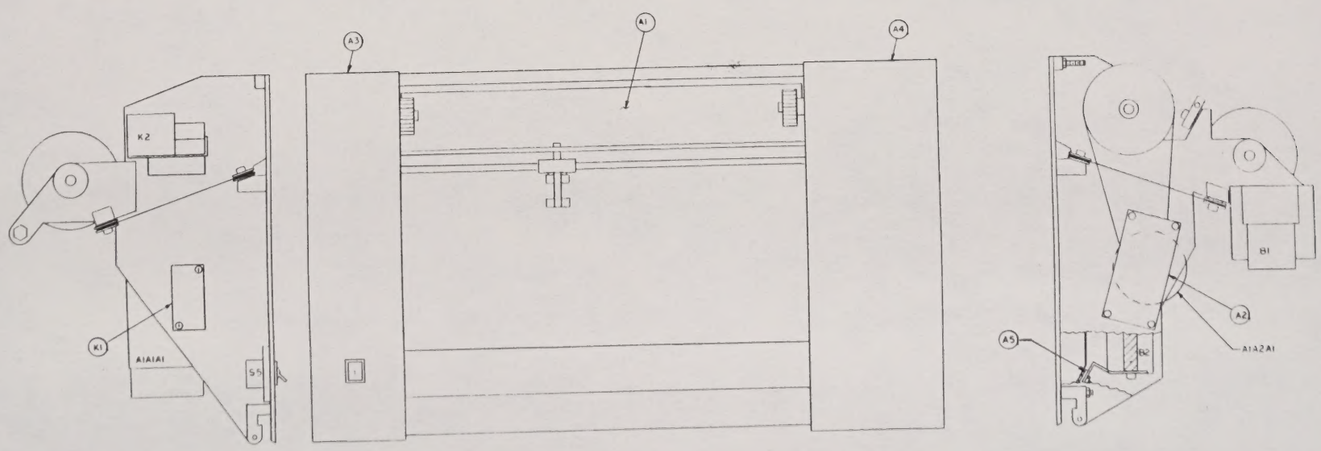

Figure 7-4. Recorder Head Assembly (A1), Outline Drawing